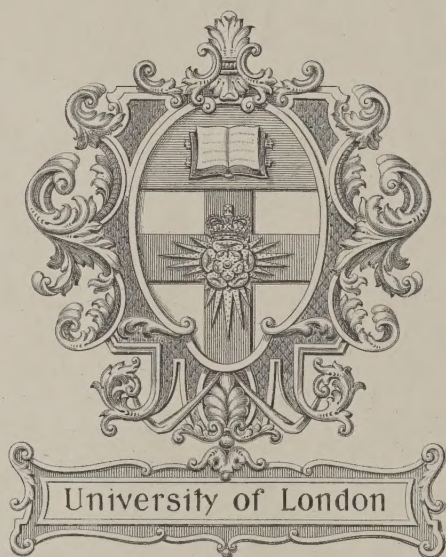












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ACCOUNTS AND PAPERS:

THIRTY-NINE VOLUMES.

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— (4.) —

A R M Y.

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ARMSTRONG AND WHITWORTH COMMITTEE.

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Session

1 February — 10 August 1866.

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VOL. XLII.

1866.

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# ACCOUNTS AND PAPERS:

1866.

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## THIRTY-NINE VOLUMES:—CONTENTS OF THE FOURTH VOLUME.

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N.B.—*THE* Figures at the beginning of the line, correspond with the N<sup>o</sup> at the foot of each Paper; and the Figures at the end of the line, refer to the MS. Paging of the Volumes arranged for *The House of Commons*.

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### A R M Y:

#### Armstrong and Whitworth Committee:

- [3605.] Report of the Special Committee on *Armstrong* and *Whitworth*  
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# R E P O R T

OF

## THE SPECIAL ARMSTRONG AND WHITWORTH COMMITTEE.

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VOL. I.

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## R E P O R T.

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Presented to both Houses of Parliament by Command of Her Majesty.

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LONDON:

PRINTED BY GEORGE EDWARD EYRE AND WILLIAM SPOTTISWOODE,  
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.  
FOR HER MAJESTY'S STATIONERY OFFICE.







No. 7663.—1.

SIR,

War Office,  
1st January 1863.

I HAVE the honour to inform you that Sir G. C. Lewis, with the concurrence of His Grace the Duke of Somerset, has decided to form a Special Committee to examine and report upon the different descriptions of guns and ammunition proposed and brought forward by Sir W. Armstrong and Mr. Whitworth for Land and Sea Service, together with other important matters connected therewith.

I am directed to make known to you that the Secretary of State has, with the concurrence of His Royal Highness the Field Marshal Commanding-in-Chief, appointed you to act as President of the Committee, of which the following officers are appointed members :—

Colonel J. W. Ormsby, Royal Artillery.

Colonel A. J. Taylor, Royal Artillery, Commandant of the School of Gunnery, Shoeburyness.

Captain George Preedy, C.B., Royal Navy.

Colonel L. A. Simmons, C.B., Royal Engineers.

Commander M. Singer, Royal Navy.

Major C. F. Young, Royal Artillery, Director of Artillery Studies.

*Secretary* :—Captain H. C. S. Dyer, Royal Artillery, Assistant Inspector of Artillery.

The addresses of the several members are sent herewith to enable you to communicate to them such arrangements as you may deem necessary, and the annexed printed instructions will more fully explain the nature of the inquiry which the Committee will have to undertake and report upon, a copy of which you will be good enough to forward to each of the military officers, similar copies having been sent to the naval officers through the Admiralty.

I have, &c.

(Signed) EDWARD LUGARD.

Major-General R. Rumley,  
Inspector-General of Infantry.

No. 7663.—10.

SIR,

War Office,  
10th January 1863.

I AM directed by Sir George Cornwall Lewis to inform you that, having regard to the great importance of the numerous mechanical questions which are likely to arise during the investigations of the Armstrong and Whitworth Committee being carefully considered by competent authorities, he has thought it desirable to secure, if possible, the services of two Civil Engineers of high standing in their profession, and he has, therefore, caused a letter (copy enclosed) to be addressed to Mr. W. Pole and Mr. Penn, of Greenwich, requesting that they will allow their names to be placed upon the Committee.

I am, &c.

(Signed) ALEX. T. TULLOH,  
Director of Ordnance.

The President of  
the Armstrong and Whitworth Committee.

War Office,  
10th January 1863.

SIR,

I AM directed to inform you that Secretary Sir George Cornwall Lewis has, with the concurrence of His Royal Highness the Field Marshal Commanding-in-Chief and the Lords Commissioners of the Admiralty, appointed a Special Committee to examine and report upon the different descriptions of guns and ammunition proposed by Sir William Armstrong and Mr. Whitworth for Land and Sea Service.

The Committee consists of several Naval and Military Officers under the presidency of Major-General Rumley, and Sir George Lewis is anxious, if possible, to secure the assistance of two Civil Engineers of high standing, in order that the numerous mechanical questions which are likely to arise during the investigation may be carefully considered by competent authorities.

I am therefore to state that, if you are willing to render your valuable services in connexion with this inquiry, it will afford Sir George Lewis much satisfaction to place your name upon the Committee.

I am to add that a similar letter has been addressed to Mr. Penn.

I am, &c.  
(Signed) EDWARD LUGARD.

W. Pole, Esq.,  
Geological Museum,  
Jermyn Street.

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## INSTRUCTIONS FOR THE SPECIAL ARMSTRONG AND WHITWORTH COMMITTEE.

THE Committee are appointed to examine and report upon certain facts, which require to be carefully ascertained before any satisfactory opinion can be pronounced upon the different descriptions of guns and of ammunition proposed by Sir W. Armstrong and by Mr. Whitworth.

It is intended that the inquiry should embrace the fitness of the guns and ammunition for the various purposes to which ordnance may be applied, namely :—

### *For Land Service.*

- |                   |                                   |
|-------------------|-----------------------------------|
| 1. Field guns.    | 3. Siege guns.                    |
| 2. Garrison guns. | 4. Heavy guns for coast defences. |

### *For Sea Service.*

- |                    |                      |
|--------------------|----------------------|
| 1. Broadside guns. | 3. Boat guns.        |
| 2. Pivot guns.     | 4. Guns for cupolas. |

### *Applicable to both Services.*

1. Guns for use against iron plates.

The Committee in considering the fitness of the guns for the several purposes above-named should report upon the comparative qualities of the different guns and ammunition under the separate heads of—

Range.  
Initial velocity and retardation.  
Accuracy.  
Penetration.  
Ease of working.  
Recoil.  
Rapidity of firing.  
Capacity for firing different kinds of projectiles.  
Apparent capability of standing the rough usage of actual service, so far as can be ascertained from—  
    Endurance.  
    Capability of bearing continued firing, with the maximum charge adapted to the gun.  
    Simplicity of construction.  
    Facility of repair.

And—

Comparative cost, so far as can be ascertained, before the manufacture has been systematically established.

The Committee will report upon the suitability of these guns for—

|                 |                 |
|-----------------|-----------------|
| Muzzle loading. | Breech loading. |
|-----------------|-----------------|

As the Committee may not have an opportunity of comparing guns of the same weight, they will carefully note the comparative weight of all guns examined, and also

|                  |                               |
|------------------|-------------------------------|
| their calibre ;  | their construction ;          |
| their material ; | their system of manufacture ; |

and they will state any facts on these points which experiment may enable them to ascertain.

In considering the projectiles, fuzes, and ammunition proposed, the Committee should include in their inquiry—

*For Field Guns.*

1. Solid shot.
2. Segment (or Shrapnel) shells with concussion and time fuzes and bursters.

*For Garrison and Siege Guns, and Guns of Position, and for Guns for Sea Service.*

1. Solid shot.
2. Segment (or Shrapnel) shells with concussion and time fuzes or bursters.
3. Common shells with percussion fuzes.

*For Use against Iron Plates.*

1. Solid shot.
2. Shells and fuzes.

They should give their attention to the various purposes for which projectiles would be required to be used with each class of gun—such as against troops at long or short ranges; against earthworks, masonry, or iron defences; against wooden, iron, or iron-plated ships, either from other vessels or from fixed batteries; for ricochet fire, penetration under water, &c. They should not overlook the applicability of the guns submitted to them to employment with special projectiles, such as shells filled with molten iron, &c. They should report on the material and shape of the various projectiles for the different purposes required. They should also satisfy themselves as to the fitness of the various projectiles and their parts to bear carriage, whether in limbers, ammunition waggons, or on board ship; their liability to deteriorate by damp, immersion in water, hot climates, &c.; their simplicity of construction; freedom from liability to injury by rough usage; and comparative cost, so far as can be ascertained, before the manufacture has been systematically established.

In considering guns and projectiles intended for use against iron plates, they should have regard to their penetration, both when fired obliquely and at right angles to the target, to their smashing effect, as well as to their destructive power after passing through the plate; on these points the results obtained by the inquiries of the Iron Plate Committee should be fully examined.

As a great number of experiments have been made of late years with the guns and projectiles proposed both by Sir W. Armstrong and by Mr. Whitworth, the Committee should examine the officers who have conducted them, as well as those who have had experience of the use of any of the guns brought under their notice with troops, either in the field, or in time of peace, or on board ship. They need not repeat experiments of which the results have been already ascertained by competent witnesses, but will direct their special attention to elucidate such points as may appear to them to require further examination.

To guide the Committee in this inquiry, all the information in the possession of the War Office, the Horse Guards, and the Admiralty will be placed at their disposal; and they will make application to the War Office before incurring expenditure for such experiments as may be deemed necessary.

The Committee should report from time to time so soon as the facts under any one head of their inquiry shall have been ascertained.

WAR OFFICE,  
December 1862.

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# R E P O R T.

THE Special Committee appointed by Sir G. C. Lewis, with the concurrence of his Grace the Duke of Somerset, to examine and report upon the different descriptions of guns and ammunition proposed and brought forward by Sir W. Armstrong and Mr. Whitworth for land and sea service, together with other important matters connected therewith, have the honour to submit the following preliminary Report.

Appointment  
of Com-  
mittee.

The Committee, as constituted by the letter of the Under Secretary of State for War, dated 1st January 1863, was composed of five military and two naval members, to whom were added, by letter dated 10th January 1863, two civil engineers, Mr. Penn and Mr. Pole. Captain Wilson, R.N., was substituted in February 1864 for Captain Preedy, R.N.; and on the 26th April 1864 the Secretary of State for War, in compliance with Mr. Whitworth's wish, approved of Mr. McDonald acting as a member of the Committee during Mr. Penn's absence through indisposition; and in February 1865, Mr. Pole having resigned, his Lordship appointed Mr. Stuart Rendel, who had attended all the experiments made by the Committee, as Sir William Armstrong's representative.

Constitution  
of Com-  
mittee.

The Committee held their first meeting on the 4th January 1863, when they decided on commencing their proceedings by the examination of the two competitors, with a view to obtaining from them descriptions of their respective inventions and proposals.

Their rival systems of artillery are described in their evidence and letters, which are to be found in the Appendix, and of which the following is a summary:—

Sir W. Armstrong's propositions (which are very comprehensive, including guns, projectiles, fuzes, &c.,) comprise two distinct natures or principles of rifling, in one of which the piece is loaded by the breech, and in the other by the muzzle; but he considered it a "question more for the service than for him to say which is the proper gun to use."

Sir W. Arm-  
strong's  
proposals.  
Q. 156. Sir  
W. Armstrong.  
Q. 147. Sir  
W. Armstrong.  
Breech-load-  
ing gun.

In the first, which will hereafter be distinguished as the breech-loading gun, the principle of rifling is the same as that at present adopted in Her Majesty's service universally for field artillery, and in a great measure for heavy artillery, both for land and sea service; in it the projectile is introduced into the bore through an aperture in the breech in prolongation of the bore, which is closed in various guns, according to two different methods,—

1st, by a plug in which is the vent, hence called the *vent piece*, inserted from above, and forced tight against the bore by a hollow screw, through which the projectile and charge are introduced into the chamber; this screw is turned by a running handle, which operates also as a hammer for tightening the parts and disengaging them;

Q. 123. Sir  
W. Armstrong.

2nd, in all large breech-loading guns of higher calibre than the 40-pounder, by a stopper or slide, on which is placed a tin cup to prevent the escape of gas; this stopper is worked in a groove through an opening in the side of the gun, and keyed up firm against the end of the bore by a wedge driven in behind it; the vent in this latter case is at some distance up the chamber from the end of the bore, and an arrangement is made by which it remains closed, and the piece cannot be primed until the stopper and supporting wedge are in their correct positions, so that the gun cannot be fired by any possibility until everything is ready.

Q. 126. Sir  
W. Armstrong.

The rifling in the breech-loading gun is many-grooved, and consists of a number (from 32 in the 6-pounder to 76 in the 7-in. gun) of parallel grooves cut in the bore, a certain length of which, however, is left plain for the cartridge, and then a certain length, called by Sir W. Armstrong the "bullet chamber," somewhat wider than the general bore, but rifled with grooves to half the full depth.

Q. 140. Sir  
W. Armstrong.

The projectiles are of cast iron or steel, cylindro-conoidal in form, the cylinder being covered with a coating of lead, the back end of which is larger than the bore, so that when inserted through the breech and run up, it chokes upon the back end against the shallow grooves of the bullet chamber, and at the same time the forward end is brought into contact with the full rifling, thus meeting the grooving at both ends at the same moment.

Q. 141. Sir  
W. Armstrong.

The service charge is, as a general rule, one-eighth of the weight of the shot, and by its

Q. 146. Sir  
W. Armstrong.

explosion forces the projectile along the bore, making it take the form of the grooves, which give it a rotatory motion.

Muzzle-loading gun.

Q. 147. Sir W. Armstrong.

In the principle of rifling adopted by Sir W. Armstrong for his muzzle-loading guns, and to which he has applied the name of the shunt principle, he has conformed to a certain extent to the principle of the many grooved breech-loading system with its lead-coated projectiles, "the rotation being given by the use of a soft material, which has the property of self-adaptation, so as to distribute the strain over the whole of the grooves," 3 to 10 in number, according to the calibre of the gun.

Q. 147. Sir W. Armstrong.

The projectiles are the same as the lead-coated projectiles used for the breech-loader, with the exception that instead of using an entire coating of soft metal for the purpose of giving rotation, rows of small brass studs or wings are used, which are stamped into the projectiles; the grooving is so arranged that the projectile in passing down the bore hugs one side, and in coming out hugs the opposite or driving side of the grooves, and in so doing meets with an inclined plane, which lessens the depth of the grooves very gradually towards the muzzle, so that by the time the projectile arrives near the muzzle the soft projections or studs are in contact with the bottoms of the grooves, and suffer a certain amount of compression, which is intended to take off all shaking from the projectile and deliver it steady.

Q. 191. Sir W. Armstrong.

Sir W. Armstrong makes the pitch of his rifling equal throughout the bore; it varies from one complete turn in 30 calibres to one turn in 38 calibres, which he considers the most favourable for field guns, and to one turn in 65 calibres for heavy guns.

Q. 190. Sir W. Armstrong.  
P. 129.

The projectiles for his field artillery vary from 1.783 to 3 calibres in length, and for his heavier guns from 1.33 to 2.91 calibres in length.

Manufacture of guns.

Q. 123. Sir W. Armstrong.

As to construction, Sir W. Armstrong in his evidence stated that, "the whole of his guns are upon what he calls the coil system, which consists in forming tubes by rolling up iron bars in spiral coils, and then welding them longitudinally; and when a continuous tube is necessary joining them up in the end direction." Repeated layers of these tubes are shrunk on in succession at high temperatures until the necessary thickness of metal is made up. He stated that the first gun he constructed was made with a steel barrel, the other parts all being coiled, and that he still continued to prefer that plan, assuming it to be practicable to get a material that can be depended upon, but that in all attempts he had made he had met with such disappointment in the use of steel, and so much uncertainty, that he had been obliged to abandon it, and confine himself to wrought iron; he added, however, that so much progress was being made in the manufacture of steel, and that he himself had lately been led to such improved methods of treating it, that he fully expected the time was not very distant when the original idea of using steel for the barrel would be revived, and coil guns made with an internal tube of steel. His reasons for desiring to use steel instead of coiled tubes for the barrels were, that steel is a more close, a more compact, and a more perfect material, that it is harder, and of greater durability, and that by its use defective welds would be avoided. The difficulties in making the inner tubes perfect and sound when coiled had been very great; these would be avoided if the tubes were made of steel, the employment of which he considered more important in large than in small guns.

Q. 129. Sir W. Armstrong.

Guns so constructed may be described as coil guns with steel tubes or barrels, or as steel barrels with superimposed coils of wrought iron.

Q. 206. Sir W. Armstrong.

Q. 205. Sir W. Armstrong.

Projectiles.

The projectiles fired from Sir W. Armstrong's guns may be either solid or hollow headed shot, segment shells, common or steel shells; to which have been added case shot, proposed by Lieut. Reeves, of the Royal Artillery. The whole of these projectiles, with the exception of the last-mentioned, are coated with lead or furnished with studs, according as the gun from which they are to be fired is a breech or a muzzle loader. The shells can be fitted and fired with percussion or time fuzes, or with both, or with pillar fuzes; all the fuzes are of metal. The time fuzes are ignited on the detonating principle, the time of burning being regulated by turning a graduated disc and setting it according to the time of flight; the percussion fuze explodes the charge by contact with any object struck by the shell in the course of its flight, provided the check to its velocity be sufficient. The pillar fuze is a variety of percussion fuze intended for action against ships; the details of these fuzes are, however, too complicated to describe in this Report. By the simultaneous use of time and percussion fuzes explosion of the shell is rendered almost certain, and by their omission Sir W. Armstrong considers that his segment shells will act as solid shot, so that it will only be necessary with guns of small calibre, the size of which is such as to preclude the employment of a common shell with an effective bursting charge, to carry two descriptions of projectile, the segment shell and case shot.

Fuzes.

Q. 164. Sir W. Armstrong.

The segment shell is composed of numerous cast-iron segments packed within the shell



round a hollow space, in which is the bursting charge so regulated as just to break the shell, allowing the segments to be scattered by the centrifugal force due to the rotation of the projectile.

Mr. Whitworth in his proposals disclaimed the intention of proposing any particular guns for the acceptance of the Government, but submitted for selection in the experiments to be made by the Committee a list of rifled guns which were being manufactured by his firm.

Mr. Whitworth's proposals.  
Q. 21.  
Whitworth.

He described "all his rifled guns as being of one nature or principle from the smallest bore rifle to the largest cannon or mortar," and "submitted that it is for the War Department and Admiralty to determine what are the requirements of the two services;" of which, "if informed, he would then be able to make the guns to meet those requirements; or if the object were stated, for instance, to effect penetration at a given range through a given thickness of material, he could say what gun and projectile he would undertake to make to effect that object."

Q. 34.  
Whitworth.

Mr. Whitworth's proposals therefore are limited to the nature or principle of rifling which he considers best adapted for use in artillery, whether for guns, howitzers, or mortars, including the form of projectiles to be fired from them; and to the construction and manufacture of the piece from which these projectiles are fired.

"The guns submitted by Mr. Whitworth are muzzle-loaders," and although he has made some of his guns as breech-loaders, he stated that "he has always advocated the muzzle-loaders," preferring them as "being more simple and equally quick in loading."

Q. 13.  
Whitworth.  
Q. 53.  
Whitworth.  
Rifling.

Mr. Whitworth's system of rifling may be described in general terms as an hexagonal bore with a rapid twist, although, strictly speaking, the bore is not hexagonal but has 24 surfaces. The gun is, in the first instance, bored out cylindrically; a part of this original bore is left in the centre of each side of the hexagon, making six surfaces, then there are the coming out sides of the hexagon which give six more surfaces, and the going in sides giving also six surfaces, and, lastly, the rounding off of the angles, which give six more, making 24 surfaces in all.

Q. 78.  
Whitworth.  
Q. 79.  
Whitworth.

Mr. Whitworth designates the calibre of his gun by the diameter of the circumscribing circle.

Q. 4.  
Whitworth.

"Mr. Whitworth's projectiles are made entirely of hard metal, rifled by self-acting machinery, the windage allowed being," what he considers, "sufficient to give easy loading, and to provide for the ignition of the simple time fuze by the flame of the explosion." They are tapered in rear and vary in length; but Mr. Whitworth describes his gun always by the weight of the solid shot three diameters in length, unless expressed to the contrary, the charge of powder being equal to one-sixth of the weight of this shot; he "contemplates firing very long projectiles when there is occasion for them, much longer than has been thought of before," he proposes shells four or more diameters in length, and stated that he had found no difficulty whatever in firing them 10 diameters long, but contemplates a shell gun of larger calibre in order to obtain a shell of greater capacity, if light guns, such as six-pounders, are employed for field artillery.

Projectiles.

Q. 16.  
Whitworth.

Q. 34.  
Whitworth.  
Q. 28.  
Whitworth.

Q. 34.  
Whitworth.  
Q. 26.  
Whitworth.

The pitch of rifling of the different guns submitted by Mr. Whitworth to the Committee for selection varies from one complete turn in 15.27 to one in 16.80 calibres for small guns up to 6-pounders, and from one complete turn in 17.77 calibres to one in 18.57 for heavier guns.

P. 131.  
Whitworth.

Mr. Whitworth proposes to "construct his field guns, solid throughout, of homogeneous metal." For the heavy "guns made by him for ships and fortifications" he employs an "inner tube, closed by a screw breech, and strengthened by hoops which are pressed on cold by hydraulic pressure," both inner and outer "tubes being made, without welding, of homogeneous metal."

Construction of gun.

P. 127.  
Whitworth.

On the subject of light artillery in the field, Mr. Whitworth stated that he could not help thinking that his 1-pounder would be of great importance, not as compared with large field guns, but as compared with the rifle in the open, and especially for exploding ammunition waggons with shell; the shot was 16 times the weight of the rifle ball, and for 1,000 yards its trajectory was 1° 40' as against 3° for the Enfield rifle, which requires an elevation of 1° 30' for 500 yards. At 5° it had a range of 2,300 yards; it weighed 1 cwt., or with the carriage 4½ cwt., and it would take with it into the field 200 rounds of ammunition. A battery of these guns would, he considered, be worked by 20 horses, whereas the battery of 12-pounders required 192 horses.

Fuzes.

Mr. Whitworth did not propose to employ any detonating principle in the fuzes, but to use the ordinary fuzes of the service, which ignite by the passage of the flame through the windage; and he referred the Committee to Lieut.-Colonel Boxer, Royal Artillery, for the details thereof, as well as of the shrapnel shell, which he would propose for adoption.

Q. 50.  
Whitworth.  
Q. 75.  
Whitworth.  
Q. 115.  
Whitworth.



## Analysis of evidence.

The Committee having thus obtained from the two competitors an outline of their propositions proceeded, in compliance with their instructions, to examine those officers who have conducted the experiments made of late years with the guns and projectiles proposed by either of them, as well as those who have had experience in the use of any of the guns, brought under the notice of the Committee, with troops either in the field or in time of peace, on land or at sea.

Gordon, 1763.  
" 1770.

By the returns which have been laid before the Committee it appears that previous to the 1st August 1863, 3,058 breech-loading guns rifled on Sir W. Armstrong's principle had been issued for service, the whole of which, with the exception of a few experimental wedge guns, have the vent piece with screw for closing the breech.

Of these 3,058 guns, 1,317 were of a less calibre than the 40-pounders, with a bore of 4.75 inches in diameter, the remaining 1,741 being either 40-pounders or 7-inch guns.

The experience of the use of these guns, therefore, had been very large, and much valuable information had been obtained respecting them and their projectiles, the most important of which may be shortly summed up as follows:—

## Range.

With reference to the range attained by these guns, Major Milward, R.A., who commanded a battery in China in 1860, stated his opinion that "we have no occasion for a 'longer range.'" Major Milman, R.A., Captain Instructor at Shoeburyness, considered "that as long a range can be got with this gun as would ever be required on service." Lieutenant Liddell, R.N., for four years Gunnery Lieutenant of the "Excellent," stated that "the range of every description of Armstrong gun in the service is quite sufficient 'for actual service.'" Mr. Bechervaise, an instructor of the "Excellent," said that in his opinion "the range is everything that can be required for ordinary service."

## Accuracy.

Q. Milman,  
754.  
Q. Liddell,  
965.

The accuracy of these guns is described by those who have had the most experience with them at Shoeburyness and on board the "Excellent," as well as by those who have used them on active service before an enemy, as meeting every requirement of the service, and by one witness as being as perfect as the limits of human eyesight and the accidents of wind and other circumstances will permit.

## Safety.

Taylor, 1524.

Taylor, 1531.

Taylor, 1552.

Alderson, 721.

Cox, 415.

Cox, 416.

Hewlett, 2158.

Liddell, 1148.

The evidence as to the safety of guns constructed with coils on Sir W. Armstrong's plan has been universally favourable. Major-General Taylor, R.A., a Member of the Committee, and for four years Commandant and Superintendent at Shoeburyness, stated that "it would be very difficult to burst one of those coil guns at all," and that the system "is calculated to give the men confidence in the gun;" and added, "we have instances "of guns which have been in constant work, and which have fired considerably over "3,000 rounds, and they are to all intents and purposes quite serviceable." Captain Alderson, the Assistant Superintendent at Shoeburyness, alluding to certain experimental guns which were fired with very excessive charges, considered that the system, by invariably giving notice of deterioration, afforded an element of very great confidence and security. Serjeant Cox, Staff Serjeant of the Experimental Department at Shoeburyness, stated, as to the Armstrong gun, "there is no fear of its bursting, and it is also safe," and that he never found an uncertain gun of that manufacture. Captain Hewlett, for many years in command of the gunnery ship "Excellent," feels the most perfect confidence in their safety; and Lieutenant Liddell, R.N., of the same ship, expressed a like feeling of perfect security in the system; but, on the other hand, certain defects in construction were frequently brought to the notice of the Committee.

The evidence taken before the Committee showed that it is difficult to make a perfect coil barrel. An epitome of Sir W. Armstrong's own statements on this subject will be found in the earlier part of their Report; this is fully borne out by the evidence of Mr. Anderson, Assistant Superintendent of the Royal Gun Factory, and others.

## Breech-loading arrangements.

Gordon, 1757. App. p. 132.  
Cox, 348. Milman, 891, 868,  
867, 874. Anderson, 2519,  
1796. Hewlett, 2145, 1045,  
1046. Liddell, 1044. Beau-  
chervais, 1267, 1268, 1269.  
Taylor, 1490.

As regards the breech-loading arrangements the Committee have been informed that the copper rings of the vent pieces and bouches of the guns require re-facing and renewal, after a certain number of rounds, dependent on the care and attention with which the action of the powder is observed. For this purpose complicated and costly tools, which are different for every description of gun, and require a certain amount of skill in manipulation, have to be issued and always carried on service with the guns; spare vent pieces and copper rings have also to be carried.

Liddell, 986,  
1177.

Milward, 1359.

Seymour, 1995.

Hewlett, 2134.

Gardner, 2645,

2659.

Gordon, 1774

Gardner, 2640.

Powell, 2228.

The Committee have received evidence of frequent accidents having occurred with guns of all sizes from vent pieces having been blown out in some cases, and broken in others, both on service and at practice on land as well as at sea, and as a consequence the whole of the vent pieces in the service had been recently exchanged, a new construction of vent piece having been approved. This vent piece, which had not yet been generally introduced into the service, is intended to prevent a recurrence of these accidents.



The Committee desire to refer to the evidence relative to those accidents which have occurred on active service in presence of an enemy. Cox, 254. Liddell, 992.

Major Milward, Royal Artillery, reports a vent piece having been blown out of a field gun during the China war in 1860, through the carelessness of the man who was trusted to screw it up; by this accident the traversing apparatus on the gun carriage was rendered unserviceable, but it "did not in any way affect the use of the gun." Milward, 1359, 1360.

Colonel Barry, Royal Artillery, also reports that a vent piece was blown out in China. Gardner, 2645.

Captain Seymour, C.B., Royal Navy, reports a vent piece having been blown out of a 12-pounder field piece in an expedition against some of the natives of the Fiji islands in 1861, by which the English consul was badly burnt, the officer in charge of the boat and six men were wounded, one of them seriously. Seymour, 1995.

Two similar accidents were reported to have occurred with the guns of the Royal Artillery in New Zealand. Seymour, 1995.

It appears also from the reports from Her Majesty's ships engaged at Kagosima, Japan, on the 15th and 16th August 1863, that with the eight 110-pounder guns which were engaged, and fired altogether 168 rounds, one vent piece was broken, and complaints were made of the vent piece jamming, and of great difficulty being experienced in firing one gun, in consequence of the rain wetting the vent piece and running into the chamber. On the same occasion 187 rounds in all were fired from the thirteen 40-pounders engaged, in the course of which one iron and four steel vent pieces were cracked, one steel vent piece was broken, and two vent pieces were blown out. O. S. C. report, 316. Minute, 10,553. 18/12/63.

These reports, which are the recorded evidence of a very limited use of the breech-loading Armstrong gun with old pattern vent pieces on active service, may be considered as indicative only of what might be expected in more serious affairs, such as a general action or decisive battle, in which a numerous artillery would be employed; combined with other evidence they tend to show that the vent piece is an element of insecurity which has been found objectionable even at practice, and may therefore be expected to be much more so in the hurry and excitement of action. Milward, 1372. Gardner, 2646-7. Liddell, 986 to 990.

The last approved pattern of vent piece is also stated as being liable to jam occasionally with the 7-inch breech-loading gun so as to cause inconvenience. M. Gunner Cox, 367 to 371. Milman, 828, 901. Liddell, 1008-9, 1035. Bechervaise, 1209 to 1213. Powell, 2294-5, 2305.

In the heavier guns, such as the 7-inch gun, the weight of the vent piece is so great that the loading becomes laborious. Milman, 790-801.

The Committee have to remark that so far as the evidence before them goes the 40-pounder breech-loading Armstrong gun with the improved form of vent piece appears to give general satisfaction. Major-General Taylor, Royal Artillery, who has had four years of constant experience of it at Shoeburyness, in practice both instructional and experimental, has the highest opinion of it. Captain Alderson, Royal Artillery, and Major Milman, Royal Artillery, also speak of it most favourably. No instances have been known at Shoeburyness of vent pieces having been blown out since the introduction of the improved form; the range and accuracy of this gun has been uniformly good.

Objection has also been taken to the breech screws of the old pattern, which by some witnesses have been described as having been liable to have their threads stripped off them; but no report has been brought before the Committee that any accident of this nature has occurred with the bevelled thread now used in the service. Breech screw. M. Gunner Cox, 265. Engineer Cox, 437. Alderson, 598. Anderson, 2543. Barry, 2645.

The opinions formed by officers of great experience on the breech-loading system which has been adopted into the service with the arrangement of shifting vent piece and breech screw seem all to point to the same conclusion. Major-General Taylor, Royal Artillery, considers "that there is an uncertainty about the vent piece, especially with a large gun; but keeping to the field guns, we have had no accidents with the last pattern vent piece that has been introduced; and I think that in the great majority of cases of injury to the vent pieces that have occurred, neglect has been at the bottom of them, and a hasty performance of simple duties." General opinion of breech-loading arrangements. Taylor, 1487.

Captain Hewlett, Royal Navy, who has seen a great deal of practice with the service gun, "has the highest opinion of it in every way as to its safety, range, and accuracy, believes it to be a perfectly safe gun with common care, but thinks that, in the excitement of action, probably the screwing up of the vent piece would be neglected," the effect of such an accident being, as he described, so very violent with a gun of moderate calibre as to shake down the bulkheads of some of the cabins. Hewlett, 2049. Hewlett, 2135.

The Committee were further informed by the Principal Superintendent of Stores, in January 1863, that the changes in the breech-loading system had been so frequent that he did not believe that in the existing state of things it would be possible, in case of



operations on a large scale, to maintain the guns in all the foreign stations, and to supply them with all the necessary articles.

This evidence, coupled with the fact that Sir W. Armstrong does not now propose to apply the breech-loading arrangements with shifting vent piece and breech screw to any guns larger than the 40-pounders of 4.75 inches calibre, and that it is even doubtful whether he would recommend it for that gun, has rendered it unnecessary for the Committee to test this system of breech-loading for any heavier description of guns than the 12-pounders; and the experience gained with the 1,741 guns, either 40-pounders or guns of a higher calibre, which have been passed into the service, and been employed on board ship in all parts of the world, and in action in China, Japan, and elsewhere, has been of comparatively little use in the consideration of the relative merits of the guns now brought forward by Sir W. Armstrong, and which alone of all the guns made upon his system have been referred to the Committee for report.

As, however, Sir W. Armstrong's guns with this breech-loading arrangement are exclusively used with field artillery in the British service, and it appeared that several improvements had been lately introduced, which have not as yet been generally applied, and as Sir W. Armstrong still proposes that these guns should be supplied for the service of field artillery, the Committee decided, before expressing an opinion on the merits of these field guns, to test one of the latest manufacture with all improvements which have been introduced up to the present time, in the competitive trials which they considered it advisable to make.

The information which the Committee were able to obtain relative to the wedge system now proposed by Sir W. Armstrong for all heavier natures of breech-loading guns was of a very limited character; the only guns that had been made of this construction were experimental guns, with which comparatively few rounds had been fired previous to the inquiry entered upon by the Committee.

Captain Hewlett, Royal Navy, from an experience of 50 rounds with a 40-pounder, and a like number from a 70-pounder gun, prefers this system to the screw as "doing away with the liability of the vent piece not being screwed up;" he would introduce it with all guns, provided the wedges will stand well the explosion of the larger charges.

Captain Alderson, Royal Artillery, who has had large experience as Assistant Superintendent of experiments at Shoeburyness, and had seen a few trials conducted with the wedge arrangement, informed the Committee that although he considered that arrangement good for the 70-pounders, he preferred the screw breech for field guns.

Mr. Anderson stated that only two such guns having come under his notice, he had not had sufficient experience to allow him to form an opinion as to the merits of the system, but added, relative to the construction, that if there should be any escape of gas and guttering, there would be much difficulty in re-bouching the end of the bore when necessary, involving a still more complicated set of tools, and greater skill in using them than with the breech-loading guns with shifting vent piece and screw.

With both the wedge and screw arrangements for breech-loading the projectiles depend for their rotatory motion upon the lead coating by which they are surrounded being forced through the grooves of the gun; it is of the utmost importance therefore that the experience obtained in the use of these projectiles should be most carefully considered.

When Sir W. Armstrong's guns were first adopted into the service the lead was fixed to the iron of the projectile by a chemical process, tin being used as the medium for cementing the two metals, but in little more than a year it was discovered that all these projectiles were likely to become unserviceable in consequence of there being no adhesion whatever between the lead and iron, and an order was issued in February 1861 that all shells were to have their lead fixed by a system of undercutting, which consists of a number of parallel grooves undercut into the iron of the projectile, and into which the lead enters. This latter plan has since, however, been found to be defective, and has been abandoned in the service; and all the shells, the lead of which is attached by the undercut, as well as those in which it is attached by the tin process, are in course of being returned to the laboratory at Woolwich to be releaded by another process, termed the zinc process, in which zinc is used as a medium for cementing the lead and iron.

The Superintendent of the Laboratory Department informed the Committee that this latter system had answered so far perfectly, and that there had been no loosening whatever of the lead, but that he should be sorry to express an opinion that even this process will stand all climates.

The Assistant Superintendent of the Laboratory at Devonport, whose duty it is to prepare and pack all ammunition for ships in commission, and receive the ammunition from ships that are paid off at Devonport, speaks of the lead having become loose,

Armstrong,  
126, 127.

Wedge  
system of  
breech-  
loading.  
Gordon, 1770.

Hewlett, 2078.  
Hewlett, 2079.

Alderson, 596,  
597.

Anderson, 2970.  
Anderson, 2977.

Anderson, 2558.

Lead-coated  
projectiles.

Boxer, 1681.

Gordon, 1785.  
Boxer, 1677.  
Boxer, 1687.

Gordon, 1784.

Boxer, 1677.

Boxer, 1684.

Bent, 2758-9.



however attached to the projectiles, and cites cases in which the zinc process had failed, apparently from defective manufacture; he had as yet had scarcely any opportunities for observing it.

The Committee were informed that the projectiles in which the lead is attached by the zinc process have only been issued for service since the month of September 1861; this appears to be scarcely a sufficient time to afford a good practical test of the permanent value of this process, which after a time, as has been the case with the processes which have preceded it, may possibly be found defective. Gordon, 1787.

The Committee have received various evidence as to the liability of the lead to strip from the iron of the projectiles when fired, by which means a number of fragments of lead are projected to the front, covering a certain distance from the muzzles of the guns. This effect has been observed in practice as well as on service, and is described as being objectionable; if common, it would prevent the employment of artillery against an enemy over the heads of advanced troops or batteries, and shows the importance of a thoroughly sound and durable attachment between the two metals, but as the recorded cases appear all to have occurred where shot were used in which the lead was attached by one of the processes since abandoned, the Committee left the further consideration of this subject until they could make their own experiments.

The lead coating which by some is considered advantageous as placing a soft material between the hard metal of the shot and the grooves in the bore, is considered by other witnesses to be disadvantageous, as being liable to injury to a certain extent, especially with projectiles of large calibre, by getting out of shape from rough usage. Hewlett, 2076.

Although the witnesses generally considered that the defects so caused might be readily reduced by the men serving the guns, the Committee have learnt that of 1,476 old pattern shells for 12-pounder guns delivered into store by two batteries of Royal Horse Artillery in 1862, when their armament was exchanged, 384 were unserviceable (282 in consequence of the lead being loose on the body of the projectile, 52 in consequence of damage done to the lead, and 48 from the bottoms being loose). They have further been informed by the Assistant Superintendent of the Laboratory at Devonport that it gives an immense deal of trouble to his department to smooth lead-coated projectiles when returned from service so that they shall pass the various gauges, and be fit for re-issue. M. Gunner Cox, 372 to 377.  
Liddell, 1098 to 1107.  
Bent, 2779.  
Taylor, 1546.  
Gordon, 1819.  
Alderson, 637.  
Liddell, 1098 to 1107.  
Bechervaise, 1286-7.  
Hewlett, 2076.  
Anderson, 3002.  
Gordon, 1822-3.  
Report of Inspector of Artillery, dated 10/3/62.

Major Milward, R.A., who commanded a field battery in China, stated, however, that his shells, although they had a great deal of knocking about from the nature of the service on which they were employed, were not in any way damaged. Bent. 2779.

The employment of the lead-coated projectile which, when fired from Sir William Armstrong's breech-loading gun, closes the bore so that there is no windage, has rendered necessary the exclusive adoption of fuzes igniting upon the detonating principle. 82  
302  
384

These fuzes may be either "time" or "percussion" fuzes. Fuzes.

As misapprehension may arise from the want of a clear understanding of these terms, the Committee think it desirable to define the sense attached to them as used in their Report.

Time fuzes may be ignited either by the flame passing the shell through the windage, or by a detonating arrangement made to act by the shock caused by the explosion of the charge in the gun. The Committee have adopted the designation of "Common time fuze" for the former, and "Detonating time fuze" for the latter.

Percussion fuzes are those which require a double action before igniting the charge within the shell; by the first, which takes place upon the firing of the gun, the fuze is set in action, or as it were "cocked," so that upon its striking an object which checks its motion the second action takes place, and the hammer within the fuze, which has been freed by the first action, is by its own inertia carried forcibly against the detonating composition, by the firing of which the bursting charge of the shell is ignited.

"Pillar" fuzes are a peculiar construction of "Percussion" fuze, so arranged that they will explode on striking a hard object presenting a certain amount of resistance, whatever may be the position of the axis of the shell with reference to that object, and are intended especially for sea service, so as not to explode on grazing water, but to ensure the explosion of shells upon striking a ship, even though they might have been disarranged in their flight by ricochetting on the water, and not be moving with their fuzes foremost.

According to the evidence taken by the Committee, it appears, that although a detonating time fuze has been a necessity ever since the introduction of the Armstrong guns into the service, and a percussion fuze has been considered to possess certain advantages for particular purposes which render its adoption of very great benefit, there has hitherto been considerable difficulty in obtaining any fuze in which the detonating principle is Milman, 846-7.  
Milward, 1319.  
Gardner, 2698.

employed, whether a time or a percussion fuze, which fully answers the requirements of the service.

The Committee have been particularly desirous of collecting, from the large experience of detonating time and percussion fuzes which have been admitted into the service and been in use in all parts of the world ever since the adoption of the Armstrong guns, information which shall be conclusive as to their merits.

According to the evidence taken by the Committee the experience with Sir W. Armstrong's fuzes of the old patterns, the number of which is very great, has not been satisfactory, especially as to their durability; the detonating time fuzes sent for use in the China war, in 1859, were all so damaged on the passage out as to be unfit for use, and the percussion fuzes were so injured by damp in transit that they were taken to pieces before using, and repaired by the civil artificers sent out with each battery, after which they acted well.

Major-General Taylor, R.A., informed the Committee that the old pattern detonating time fuze had certainly deteriorated since he first took the command at Shoeburyness, in 1860; the practice at that time with that fuze was as nearly perfect as anything could be, and the failures were very rare indeed. Such had not been the case during the past year; the burning of those fuzes had become very irregular, and the examination of them had shown that the interior had been injured by various causes, by damp, or perhaps by chemical action within them.

The Superintendent of the Royal Laboratory has great doubts as to the keeping of the last pattern fuzes for causes which he explained. He informed the Committee, that the whole of the detonating time and percussion fuzes in store had been lately condemned, and there had been no experience of the present fuzes.

Captain Hewlett, Royal Navy, informed the Committee with regard to Sir W. Armstrong's detonating time fuzes of the old pattern that their action was irregular, and that after they had been issued about 18 months a deterioration was observed which was very rapidly progressive. He stated that in recent reports from many ships abroad the same defects were described, some of the fuzes bursting prematurely, others not bursting at all.

Captain Hewlett, after long experience with the various fuzes of the service which ignite upon the detonating principle, gave it as his opinion that he would certainly prefer fuzes ignited by the charge if it were possible to employ them.

These statements, so far as they relate to the old pattern fuzes, have been fully corroborated by various evidence, both of naval and military men; whereas favourable opinions have been expressed as to the new pattern fuzes, but sufficient time has not elapsed to enable a judgment to be formed of their durability. The Committee desire particularly to direct attention to the evidence of the Principal Superintendent of Stores, and of the Assistant Superintendent of the Laboratory at Devonport, who raise objection to the construction of these fuzes on the ground of the impossibility of examining them to ascertain whether they are complete in all their parts, and in working order, both when first received into the service, and when returned into store after having been issued.

Cases have occurred recently in which fuzes issued for service have exploded in the limber boxes while guns have been at exercise, and the general result of the use of these fuzes for many years may be summed up by stating that the pattern of fuze was so undetermined at the commencement of 1863 as to have been still under consideration.

With regard to the pillar fuzes, the Committee have been informed that they answer well in firing, and they have had no evidence of any accident having occurred with them on service or at practice. A pillar fuze belonging to the first batch manufactured in the Royal Laboratory exploded while in course of removal from the laboratory to the store, and in consequence none of that batch, 15,000 in number, were issued. These fuzes are also considered as too delicate and liable to accidents by Colonel Boxer, R.A.; and Captain Bent, R.A., Assistant Superintendent of the Laboratory at Devonport, stated, in February 1863, that they had been in the service some year or a year and a half, but in the course of that time they became so fixed in the shell that it is very dangerous indeed to remove them; he added, however, "that none had exploded."

The experience therefore of the use of this description of ammunition, into which, among others, the Committee were directed to examine, has been of little assistance in guiding them in reporting upon what is now proposed by Sir W. Armstrong, beyond pointing out that the uncertainty attending all fuzes in which the detonating principle is involved has prevented the establishment of confidence in their action, or in their safety as compared with the common time fuze of the service, which cannot possibly be ignited except by putting fire to it.



Having thus given a summary of the evidence relative to the experience gained with the breech-loading guns proposed by Sir W. Armstrong, so far as it applies exclusively to them, the Committee have to report that, when they commenced their investigations in 1863, no muzzle-loading gun rifled upon the shunt principle proposed by Sir W. Armstrong had been admitted into the service, and no such gun had been sent to the "Excellent" for trial, and no 12-pounder had then been made on this principle. Major Milman stated that only one 120-pounder gun had then been delivered for experiment at Shoeburyness, which had only been practised with at short ranges of 200 yards against iron plates; so far as they had gone, the few trials made with this gun had been satisfactory, both as to accuracy and ease of working, which was described as being greater than that of the 110-pounder 7-inch breech-loading gun.

The projectiles intended for both the breech-loading and muzzle-loading guns proposed by Sir W. Armstrong are similar, so far as the iron and internal parts are concerned.

The Committee have received very satisfactory evidence as to the destructive effect of the segment shells proposed by Sir W. Armstrong. When used in China, notwithstanding the imperfections of the fuzes, the shells in some cases, owing to the peculiar construction of the parapets, were burst in the most favourable positions by the action of the percussion fuzes, and in other cases by their action against the ground in front of bodies of men in the open field. Great advantage has also been gained by the simplicity of having only one kind of projectile, the segment shell, to provide and carry, for guns in the field, which can be used for all purposes, but there appears to be a universal opinion among the witnesses who were examined that the shell does not adequately supply the place of case shot, inasmuch as it cannot be made to act at distances under 150 yards.

A general opinion appears also to prevail that the employment of the segment shell does not do away with the necessity of having guns in the field adapted for firing common shells capable of containing adequate bursting charges.

An endeavour has been made to supply the want of a good projectile for shorter ranges than those at which the segment shell is effective, by the introduction of case shot proposed by Lieut. Reeves, Royal Artillery, but no experiment had been made with them, nor, so far as the Committee were informed, had any experiments been made to determine the extreme spread of the fragments of the segment shell under different conditions. The Committee therefore have considered it necessary to carry out an elaborate series of experiments with the segment shell to record its precise effects in a manner which will permit of comparison with other projectiles submitted to them, and intended for use under similar circumstances.

From the evidence taken by the Committee in January 1863, with respect to the penetration of iron plates, it appeared that Sir W. Armstrong had penetrated with a shell into the backing of a Warrior target, and blown a hole through the skin with a 110-pounder gun at 200 yards' range.

Sir W. Armstrong has also constructed guns of great calibre and power which are reported by the Iron Plate Committee to be capable of penetrating at long ranges any iron target that has yet been fired at.

The Committee have been able to obtain very little information calculated to assist them in forming an opinion on the guns and ammunition submitted and brought forward by Mr. Whitworth.

Some practice had taken place at Shoeburyness some years ago with 12-pounders to test the rapidity of firing from guns made upon the systems proposed both by Sir W. Armstrong and Mr. Whitworth for breech-loading. The rapidity of firing was greatly in favour of Sir W. Armstrong's gun, but in consequence of some defects of construction the test was not considered fair for the gun proposed by Mr. Whitworth, who has since given up that system of breech-loading; the practice with both guns was described as very good.

In 1862 an iron 70-pounder and a brass 12-pounder rifled upon Mr. Whitworth's plan were tried at Shoeburyness, and gave very satisfactory results as to range and accuracy; the ranges were reported as a little in excess of those of the similar Armstrong gun, but some difficulty was experienced in loading.

Some practice also was made with an iron 120-pounder gun constructed with coils, and rifled on Mr. Whitworth's plan.

Major-General Taylor, R.A., informed the Committee that he had not seen any of Mr. Whitworth's guns give way, that he considered them perfectly safe, but he had not seen many rounds fired from them, and that the experiments which had been made were not sufficient to permit of any decisive conclusion being formed as to their durability.

An experiment had also been made by rifling four brass guns as 12-pounders on

Sir W. Armstrong's muzzle-loading or shunt gun. Hewlett, 2198. Alderson, 647. Milman, 813 to 818. Sir J. Hay, 1848. Milman, 810 to 818. 814.

Segment shells. Milward, 1337, 1338. Harrison, R.E., 1866. Milward, 1364. Liddell, 1138, 1144. Glyn, 1977. Seymour, 2042. Hewlett, 2191.

Case shot.

Alderson, 628. Liddell, 1144.

Penetration of iron plates.

Whitworth gun.

Taylor, 1480-4.

Alderson, 497, 521.

Taylor, 1532, 1534.

Isacke, 2801.



Mr. Whitworth's plan, which were sent to Shorncliffe for trial. Each of these guns was on one occasion fired 150 rounds, when the practice was described as good; there was no difficulty in working them. On another occasion, when only 30 rounds were fired from each gun, the practice was not considered so good as with Sir W. Armstrong's guns, but on both of these occasions precise records for comparison were not taken, and much must have depended on the men who laid the guns. These guns after 200 rounds appear to have worn considerably, and to have been deeply indented.

Captain Hewlett, Royal Navy, who was sent to Manchester five or six years ago to examine and report upon Mr. Whitworth's gun, informed the Committee that at that time he considered the accuracy and range would be very great, but he considered Mr. Whitworth's breech-loading arrangements very defective, and he doubted the safety of the gun, because he had seen the principle of hard metal in projectiles working against hard metal in guns, and they had burst, and he believed no gun would stand metal working upon metal with a severe twist of rifling for any long period of time; he also spoke of the difficulty of loading after a few rounds caused by the deposit from the powder getting into the angles of the rifling and hardening there, but stated that only the ordinary sponge of the service had been used, and not a sponge constructed purposely for Mr. Whitworth's gun, and that he had only fired about 30 rounds in all.

Captain Hewlett further informed the Committee that on a trial of an 80-pounder made of homogeneous metal it split after 20 or 30 rounds with 12-lb. charges. A gun, also bored on Mr. Whitworth's plan out of a 68-pounder cast-iron block, had burst on board the "Stork" gunboat.

The experiments with Mr. Whitworth's gun had developed a superiority over Sir W. Armstrong's gun in penetrative effect against iron plates, the greatest penetration up to January 1863 having been attained by a projectile from Mr. Whitworth's 120-pounder iron gun. On this subject the Committee refer to the evidence of Captain Harrison, Royal Artillery, Secretary to the Iron Plate Committee, who stated that until the experiments were made with Mr. Whitworth's projectiles it was "considered that the 'Warrior' target, against any one shot, was invulnerable; and as regarded shell, no such thing was thought of as penetrating the target. In point of fact, up to that time we had only seen the 'Warrior' target penetrated by shot from the 10·5 inch smooth-bore gun; the target had been penetrated by that, but otherwise it was invulnerable, and it was not until the Whitworth experiments that the target was penetrated, but since that time the target has been equally penetrated by shell made by Sir W. Armstrong."

In these experiments by Mr. Whitworth the Warrior target was penetrated by shells fired from the 120-pounder at a range of 800 yards, and was perforated by a solid shot from the same gun; the armour plate was also penetrated at a range of 600 yards by a shell, fired from a 70-pounder gun, which burst in the wood backing, but the skin was not penetrated.

This effect has been attributed to the material of which the projectile is made, the discovery of which has been described by Captain Sir J. Hay, Royal Navy, President of the Iron Plate Committee, as Mr. Whitworth's principal merit.

So far as the Committee have been informed, no experiments have been made with any of Mr. Whitworth's guns and projectiles to test their power of penetrating iron targets subsequent to those reported as having taken place early in 1863.

Various opinions were expressed to the Committee as to the durability of guns rifled on Mr. Whitworth's plan, some agreeing with Captain Hewlett, R.N., that the friction of the two hard metals in the projectile and in the bore of the gun is more liable to wear out and destroy the gun than would be the case where the barrel is much harder than the projectile, while others appear not to entertain any apprehension of danger to the gun from this cause. Some again apprehended risk from the rapidity of twist given by Mr. Whitworth, but on this point also there was a great difference of opinion; others contending that although greater spirality causes a slightly increased strain to the gun, which would be very objectionable with cast iron, it does not matter much with a strong material, such as wrought iron, steel, or brass.

The experience on these points being so very limited, and the principal part of it derived from guns which, although rifled on Mr. Whitworth's plan, were not made of the peculiar metal and construction proposed by him for the manufacture of his guns, it is evident that the opinions were very conjectural; the Committee, therefore, have found it necessary to ascertain the value to be attached to these opinions by special experiments carried on under their own supervision.

Such being the state of the experience obtained with the guns and ammunition proposed by Sir W. Armstrong and Mr. Whitworth for their respective muzzle-loading systems, it is evident that no satisfactory conclusions could be drawn from it as to the

Best, 2870,  
2891.  
Isacke, 2835.  
App. p. 134.

Hewlett, 2051.

Hewlett, 2052.

Hewlett, 2058.

Hewlett, 2068.

Penetration  
of iron  
plates.

Taylor, 1508.  
Harrison, 1423.  
1414.

Harrison, 1410.

Sir J. Hay,  
1832-3.  
Harrison, 1414.  
Gen. Taylor,  
1511.  
Alderson, 666.  
1856.

Durability.

Sir J. Hay,  
1836.

Anderson,  
2472, 3180.  
Hewlett, 2052.  
Boxer, 1688.  
Anderson,  
3181-3183.



relative merits of these two systems; and although far greater experience had been gained with Sir W. Armstrong's breech-loading system, there have been so many changes and improvements in the arrangements for closing the breech and in the ammunition to be used with it, that it would not have been fair to draw conclusions as to the breech-loading system with either the shifting vent piece or slide apparatus in comparison with Sir W. Armstrong's own muzzle-loading system or with Mr. Whitworth's, unless all three systems should compete with each other under as complete and perfect conditions as the latest improvements up to the date of the trial could make them.

As their instructions gave the Committee no discretion by which they could propose experiments whereby each point of difference in the various systems might be separately tried and compared, and did not empower them to impose restrictions upon the two competitors, either as to calibre, weight or length of gun or shot, or weight of charge, or as to any other particular which either of them might think requisite for displaying the advantages of his system, the Committee called upon Sir W. Armstrong and Mr. Whitworth to furnish complete tabular statements of *all* the different descriptions of ordnance and ammunition proposed by them for siege, garrison and naval service, and also for field artillery.

These tables, therefore, which are to be found in the Appendix, contain synopses of all the guns submitted to the Committee for report; from them it will be seen that although the 12-pounders vary in some important details, they can be taken as fair types for comparison of the different systems of field artillery. With respect to heavier natures of ordnance, however, the differences in the guns proposed by the two competitors are so great that it was difficult to select those which would give results in practice admitting of a fair comparison. The heaviest gun proposed by Mr. Whitworth had a calibre of 9 inches, weighed 290 cwt., and was intended to throw a shot weighing 325 lbs., whereas the gun of most similar calibre, 9.22 inches, proposed by Sir William Armstrong, weighed only 130 cwt., or less than one-half of Mr. Whitworth's 9-inch gun, and threw a shot of 150 lbs., also less than one-half of the weight of Mr. Whitworth's, and the gun nearest in weight to Mr. Whitworth's 9-inch gun proposed by Sir William Armstrong was still 50 cwt. lighter than Mr. Whitworth's, with a calibre of 10.5 inches, or  $\frac{1}{8}$ th larger, and threw a steel shot weighing 300 lbs., or 25 lbs. less than Mr. Whitworth's.

The manufacture of such large guns and of the ammunition for thoroughly testing them would have been attended with great delay and a very large expenditure as compared with the 70-pounders, which were the least dissimilar of all the heavy guns proposed by the competitors, and therefore offered the greatest probability of a fair competitive trial.

The selection also of the 70-pounders would permit of both of Sir W. Armstrong's systems, his muzzle-loading and his breech-loading system, being tested at the same time in competition with Mr. Whitworth's, which no other guns proposed by Sir W. Armstrong would have done.

The Committee considering it very essential on the ground of economy, both of time and money, that all three systems should be tried simultaneously; considering also that possibly a decided inferiority might manifest itself with one of the three systems with a gun of moderate calibre, which would render it unnecessary to make further experiments with that system with a gun of larger calibre, and that inferences might be drawn from these experiments which might suffice to arrive at a satisfactory comparison between the other two systems, and bearing in mind the great delay and increased expenditure which would attend experiments with larger natures of ordnance, decided finally on adopting the 70-pounders for their experiments as types of the three systems for garrison, siege, or naval purposes, leaving it for after consideration whether it might not be advisable and in the interest of the public service to test one or more of the systems with guns of a still larger calibre.

The Committee, therefore, having first obtained the sanction of the Secretary of State for War, sent orders to Sir W. Armstrong and Mr. Whitworth, in February 1863, for the following guns, together with 1,000 rounds of ammunition per gun, with a request that they might be supplied with as little delay as possible.

From Sir W. Armstrong:—

- 1 12-pounder breech-loading gun.
- 1 12-pounder muzzle-loading gun.
- 1 70-pounder breech-loading gun.
- 1 70-pounder muzzle-loading gun.

From Mr. Whitworth:—

- 1 12-pounder muzzle-loading gun
- 1 70-pounder muzzle-loading gun

Selection of  
guns for  
experiment.  
App. pp.  
129 to 131.

As it was subsequently thought desirable, to prevent delay in carrying on the experiments in case an accident should happen to any of the guns, to have three of each nature, orders were given to Sir W. Armstrong and to Mr. Whitworth, in the same month, to complete their supply to that number.

The Committee fully expected that the whole of the guns would have been delivered in the course of three or four months from the date of their order, so that the experiments might have been commenced in 1863, whereas great delays took place; the causes of these delays and the steps the Committee took with the view of obviating the inconvenience that might ensue to the public service therefrom will be found in the Appendix.

Programme.

In the meanwhile the Committee proceeded to prepare a programme of experiments to be made with a view to thoroughly testing the various systems in every particular and under every condition in which it is possible that guns can be placed on service; the Committee endeavoured to make this programme as exhaustive as possible, and with a view to guard against the possibility of any advantage peculiar to either system being either overlooked or not brought so prominently to notice as either of the competitors might think warranted by its importance, the Committee submitted their programme to the competitors for any observations they might desire to offer.

This programme was at once accepted by both competitors; it will be found at page 1, App. P., in the Appendix. It contains merely the heads of the points on which the Committee deemed it necessary to experiment, but does not lay down the details of the methods by which the results were to be arrived at, nor was it intended to preclude the Committee from making any additions or alterations which might suggest themselves in the course of the experiments.

The Committee subsequently placed 200 rounds per gun at the absolute disposal of the competitors, without any restriction whatever as to their use, to enable them to bring out the merits of their respective guns on any points which they might consider insufficiently developed in the course of the experiments made by the Committee.

At the request of both competitors, the Committee agreed that the projectiles and fuzes should be supplied from their own works, with the exception of the shells for Mr. Whitworth's guns (the castings of which only were supplied by him), and the fuzes for his shells, with respect to which Mr. Whitworth disclaimed all responsibility, and referred the Committee to Colonel Boxer, Royal Artillery, Superintendent of the Royal Laboratory, by whom this portion of the ammunition for Mr. Whitworth's guns was exclusively supplied.

The cartridges and lubricators for all the guns were also supplied from the Royal Laboratory, and to eliminate as far as possible any errors due to differences of powder, the cartridges were prepared from the same lots and brands of powder.

The Committee throughout have used their best endeavours to provide against any circumstance, however trivial, which might be thought to place the competitors on an unequal footing; and in order to guard against objections being raised at any future time, which it might not only be difficult but impossible to refute, the Committee have allowed the competitors and their representatives to have access daily to the records of the practice, and have invited them to communicate with them on any points on which they were not satisfied.

Causes of delay.

The experiments were commenced at Shoeburyness on the 4th April 1864, and have been carried on from day to day, so far as circumstances would permit, without any intermission, except what has been attributable to delays in the delivery of ammunition or to other causes beyond the control of the Committee.

The Committee think it necessary to add that a very considerable delay has also been caused by the nature of the practice, a large portion of which could only be carried on at particular times of tide when the sands of Shoeburyness were not covered by water. The practice was also further impeded and much time lost by the crowding of vessels on the range.

Part of the experiments also were carried on at Portsmouth, subject to similar delays from the tide, and at Bexhill.

The Committee have also visited Sir William Armstrong's gun factory at Elswick, and Mr. Whitworth's works at Manchester.

Before proceeding to report the results of the experiments, the Committee consider it advisable to draw attention to the following Tables, giving the principal details of construction of the various guns as proposed by Sir W. Armstrong and Mr. Whitworth in January 1683, and those delivered to the Committee in 1864.



## 12-POUNDERS.

TABLE showing Dimensions of Guns and Ammunition.

|                                 | As proposed. |       |            | As delivered. |       |                  |
|---------------------------------|--------------|-------|------------|---------------|-------|------------------|
|                                 | Armstrong.   |       | Whitworth. | Armstrong.    |       | Whitworth.       |
|                                 | B. L.        | M. L. | M. L.      | B. L.         | M. L. | M. L.            |
| Weight of gun - - cwt.          | 8.5          | 8.3   | 9.64       | 8.5           | 8.93  | 10.21            |
| Calibre - - - inches            | 3.0          | 3.0   | 3.0        | 3.0           | 3.0   | { 3.02<br>2.14   |
| Length of bore - - "            | 73.5         | 67.74 | 79.0       | 73.5          | 67.74 | 74.0             |
| " " - - - calibres              | 24.5         | 22.6  | 26.0       | 24.5          | 22.56 | { 24.5<br>27.1   |
| Length of gun - - "             | 28.04        | 25.1  | —          | 27.65         | 23.91 | { 26.49<br>29.3  |
| " " - - - inches                | 84.12        | 75.24 | 85.0       | 82.95         | 71.75 | 80.0             |
| Rifling, one turn in - calibres | 38.0         | 35.0  | 18.33      | 38.0          | 35.0  | { 18.21<br>20.14 |
| " " - - - inches                | 114.0        | 105.0 | 55.0       | 114.0         | 105.0 | 55.0             |
| Charge - - - lbs.               | 1.5          | 1.5   | 2.0        | 1.5           | 1.75  | 1.75             |
| Shot, weight - - - "            | —            | —     | 12.0       | 11.56         | 11.56 | 11.9             |
| " length - - - calibres         | —            | —     | 3.0        | 2.3           | 2.54  | { 2.89<br>3.2    |
| " " - - - inches                | —            | —     | 9.0        | 6.92          | 7.62  | 8.75             |
| Segment or Shrapnel shell :—    |              |       |            |               |       |                  |
| Weight - - - lbs.               | 11.63        | 11.63 | —          | 11.5          | 11.5  | 11.93            |
| Length - - - calibres           | 2.25         | 2.4   | —          | 2.25          | 2.42  | { 2.96<br>3.28   |
| " - - - inches                  | 6.75         | 7.17  | —          | 6.76          | 7.26  | 8.96             |
| Bursting charge - - -           | 1 oz.        | 1 oz. | —          | 1 oz.         | 1 oz. | 6 or 12 drs.     |
| Common shell :—                 |              |       |            |               |       |                  |
| Weight - - - lbs.               | 12.0         | —     | —          | 11.19         | 11.19 | 11.78            |
| Length - - - calibres           | 3.0          | —     | —          | 3.0           | 3.0   | { 3.58<br>3.97   |
| " - - - inches                  | 9.0          | —     | —          | 9.02          | 9.0   | 10.84            |
| Bursting charge - - oz.         | 10.0         | —     | —          | 11.0          | 9.5   | 8.5              |
| Windage of shot - inches        | Nil.         | —     | 0.03       | Nil.          | 0.05  | 0.04             |
| " shell - - - "                 | —            | 0.04  | —          | —             | 0.05  | 0.04             |

NOTE.—The two numbers given under the head of calibre in the Whitworth gun have reference to the diameters of the circumscribing and inscribing circles.

From this Table the relative weights, lengths of bore, &c., of the various guns may be stated in round numbers as follows :—

| WHITWORTH.                                                         | M. L. ARMSTRONG.                                           |
|--------------------------------------------------------------------|------------------------------------------------------------|
| 14 per cent. heavier than M. L. Armstrong.                         | 6 per cent. heavier than B. L. Armstrong.                  |
| 20 per cent. heavier than B. L. Armstrong.                         | <i>Rifling.</i> —Twist, same as B. L. Armstrong.           |
| <i>Length of bore.</i> —Equal to B. L. Armstrong.                  | <i>Charge.</i> —17 per cent. greater than B. L. Armstrong. |
| 9 per cent. longer than M. L. Armstrong.                           |                                                            |
| <i>Rifling.</i> —Nearly twice as rapid a twist as M. L. Armstrong. |                                                            |
| <i>Charge.</i> —Same as M. L. Armstrong.                           |                                                            |
| 17 per cent. greater than B. L. Armstrong.                         |                                                            |

70-POUNDERS.

TABLE showing Dimensions of Guns and Ammunition.

|                                 | As proposed. |       |            | As delivered. |        |                       |
|---------------------------------|--------------|-------|------------|---------------|--------|-----------------------|
|                                 | Armstrong.   |       | Whitworth. | Armstrong.    |        | Whitworth.            |
|                                 | B. L.        | M. L. | M. L.      | B. L.         | M. L.  | M. L.                 |
| Weight of gun - - cwts.         | 61·6         | 60·0  | 75·0       | 62·0          | 76·0   | 78·0                  |
| Calibre - - - inches            | 6·4          | 6·4   | 5·5        | 6·4           | 6·4    | { 5·53<br>5·03        |
| Length of bore - - calibres     | 14·4         | 14·8  | 20·0       | 14·36         | 16·87  | { 19·62<br>21·78      |
| " " - - inches                  | 92·0         | 94·7  | 110·0      | 91·95         | 108·0  | { 108·5<br>21·51      |
| Length of gun - - calibres      | 23·17        | 16·87 | —          | 17·17         | 19·25  | { 23·89<br>119·0      |
| " " - - inches                  | 110·0        | 108·0 | 120·0      | 109·95        | 123·25 | { 18·08<br>20·2       |
| Rifling, one turn in - calibres | 45·0         | 45·0  | 18·18      | 40            | 40     | { 100·0<br>10·0       |
| " " " - - inches                | 288·0        | 288·0 | 100·0      | 256·0         | 256·0  | { 70·0<br>2·71        |
| Charge - - lbs.                 | 10·0         | 11·0  | 12·0       | 9·0           | 10·0   | { 3·01<br>15·0        |
| Shot, weight - - "              | 79·0         | 80·0  | 70·0       | 71·87         | 70·6   |                       |
| " length - - calibres           | 1·85         | 1·94  | 3·0        | 1·96          | 2·0    |                       |
| " " - - inches                  | 11·86        | 12·46 | 16·5       | 12·26         | 12·81  |                       |
| Segment or Shrapnel shell :—    |              |       |            |               |        |                       |
| Weight - - lbs.                 | 77·63        | —     | —          | 77·6          | 68·9   | 67·7                  |
| Length - - calibres             | 2·1          | —     | —          | 2·16          | 2·16   | { 2·81<br>3·12        |
| " - - inches                    | 13·5         | —     | —          | 13·85         | 13·88  | { 15·58<br>3 or 6 oz. |
| Bursting charge - lbs.          | 3·31         | —     | —          | 3·0*          | 3·0*   |                       |
| Common shell :—                 |              |       |            |               |        |                       |
| Weight - - lbs.                 | 69·0         | 75·0  | —          | 68·75         | 69·75  | 70·0                  |
| Length - - calibres             | 2·28         | 2·57  | —          | 2·29          | 2·28   | { 3·79<br>4·2         |
| " - - inches                    | 14·65        | 16·5  | —          | 14·66         | 14·64  | 21·0                  |
| Bursting charge - lbs.          | 4·7          | 5·3   | —          | 4·8           | 4·5    | 5·0                   |
| Common shell :—                 |              |       |            |               |        |                       |
| Weight - - lbs.                 | —            | —     | —          | —             | —      | 49·25                 |
| Length - - "                    | —            | —     | —          | —             | —      | 15·02                 |
| Bursting charge - lbs.          | —            | —     | —          | —             | —      | 2·5                   |
| Common shell :—                 |              |       |            |               |        |                       |
| Weight - - lbs.                 | —            | —     | —          | —             | —      | 67·5                  |
| Length - - "                    | —            | —     | —          | —             | —      | 18·0                  |
| Bursting charge - lbs.          | —            | —     | —          | —             | —      | 2·75                  |
| Windage of shot - inches        | —            | 0·06  | 0·05       | Nil.          | 0·06   | 0·05                  |
| " shell - - "                   | Nil.         | 0·66  | 0·05       | Nil.          | 0·06   | 0·05                  |

NOTE.—The two numbers given under the head of calibre in the Whitworth gun have reference to the diameters of the circumscribing and inscribing circles.

From this Table the relative weights, lengths of bore, &c., may be stated in round numbers as follows :—

| WHITWORTH.                                                                                                                                                                                                                                                                                      | M. L. ARMSTRONG.                                                                                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 26 per cent. heavier than B. L. Armstrong.<br>2 per cent. heavier than M. L. Armstrong.<br><i>Length of bore.</i> —Same as M. L. Armstrong.<br><i>Rifling.</i> —Twist twice as rapid as M. L. Armstrong.<br><i>Charge.</i> —11 per cent. more than B. L. Armstrong.<br>Same as M. L. Armstrong. | 22 per cent. heavier than B. L. Armstrong.<br><br><i>Length of bore.</i> —20 per cent. longer than B. L. Armstrong.<br><i>Rifling.</i> —Twist same as B. L. Armstrong. |

\* After changed to 1-lb. burster for land service.



The Committee have, in a previous part of the Report, detailed the description given by Sir W. Armstrong in January 1863 of the manner in which his guns are constructed, exhibiting the condition in that respect of his system at that period, since which it appears that such progress has been made in the manufacture of steel, that all the guns submitted to the Committee for experiment, except one of the 70-pr. breech-loaders, were constructed of steel inner tubes with wrought-iron coils superimposed, which, in the case of field guns, extended only from the breech to a short distance in front of the trunnions.

Guns submitted by Sir W. Armstrong.

The 12-pounder guns as first delivered to the Committee by Mr. Whitworth were constructed of solid steel, having trunnion rings screwed on to them.

Considerable changes also have been made in the ammunition, especially in the fuzes which have been brought before the Committee by both competitors; these changes are of such an intricate nature that the Committee do not think it necessary to detail them; they merely observe that the principle of ignition by the flame through the windage, advocated by Mr. Whitworth, was not followed in any of the fuzes submitted for trial with his shells, but all the fuzes brought before them by both inventors have depended for ignition on the employment of detonating composition.

Ammunition.

Before proceeding to detail their experiments, the Committee think it right to observe that, in the guns supplied by Mr. Whitworth, the vents were placed in continuation of the axis of the piece, the charge being ignited through them by tubes. In consequence, however, of the Commandant at Shoeburyness having stated to Mr. Whitworth his opinion that the use of a vent in this position was liable to cause injury to the men of the gun detachment from the flying of the tube, Mr. Whitworth, at the last moment before the commencement of the experiments, closed these vents and inserted others on the upper surfaces of the guns in the usual position, and added a steel cylinder over the breech of all his guns to compensate for the loss of strength due to piercing their metal, and which had not been provided for in his original construction. All the practice with his 12-pounder guns has been carried on with the vents in this position; but after firing 1,025 rounds from his 70-pounder gun with this vent, Mr. Whitworth informed the Committee that in consequence of the peculiar position of the upper vent with reference to the rifling, the gas had begun to damage the inside of the gun close to the vent, and therefore he wished to revert to his original proposition, and continue the practice from the rear vent. The Committee having ascertained that this practice could be conducted with safety with the arrangements made by Mr. Whitworth, acceded to his request, and consequently the practice with Mr. Whitworth's 70-pounder, which is referred to in the body of their Report, has been carried on by firing through the rear vent in prolongation of the axis of the gun.

Guns submitted by Mr. Whitworth.

The Committee consider it unnecessary to complicate their Report with the details of construction of all the different natures of ammunition which have been submitted to them, as patterns have in all cases been preserved, which will be delivered to the Store Department.

The Committee now proceed to report the experiments made by them, and the comparative qualities of the different guns and ammunition as deduced therefrom, under the various heads and in the order laid down in their instructions, beginning with the 12-pounder guns.

## EXPERIMENTS WITH 12-POUNDERS.

### RANGE.

The guns were placed under exactly similar conditions; 20 rounds were fired from each with solid shot, at each degree of elevation from 0° to 10°, the elevation being given by spirit level, also five rounds with shells at the same elevations; subsequently as the number of rounds fired with shell appeared to the Committee insufficient to give results which could be depended on, additional rounds of segment and shrapnel shell were fired at 0°, 3°, 5°, 7°, and 10° of elevation; 10 rounds of solid shot were also fired from each gun at 15°, 25°, and 33° of elevation.

The position of each projectile as it fell on the sands was noted; full details of each day's practice will be found in the Appendix.

The following abstract shows the general results of this practice with solid shot after elimination by the competitors of a per-centage of the most unfavourable rounds.

| No. of Rounds. | Elevation. | Range in Yards of<br>Armstrong B. L. 12-pounder.<br>Projectile, solid Shot - 11·87 lbs.<br>Charge of Powder - 1½ " |      |       |                      | Range in Yards of<br>Whitworth M. L. 12-pounder.<br>Projectile, solid Shot - 11·87 lbs.<br>Charge of Powder - 1·75 " |      |       |                      | Range in Yards of<br>Armstrong M. L. 12-pounder.<br>Projectile, solid Shot - 11·56 lbs.<br>Charge of Powder - 1·75 " |      |       |                      |
|----------------|------------|--------------------------------------------------------------------------------------------------------------------|------|-------|----------------------|----------------------------------------------------------------------------------------------------------------------|------|-------|----------------------|----------------------------------------------------------------------------------------------------------------------|------|-------|----------------------|
|                |            | Max.                                                                                                               | Min. | Mean. | Mean error in range. | Max.                                                                                                                 | Min. | Mean. | Mean error in range. | Max.                                                                                                                 | Min. | Mean. | Mean error in range. |
|                |            |                                                                                                                    |      |       | Yds.                 |                                                                                                                      |      |       | Yds.                 |                                                                                                                      |      |       | Yds.                 |
| 18             | 0          | 488                                                                                                                | 444  | 466   | 10·8                 | 522                                                                                                                  | 484  | 506   | 6·7                  | 546                                                                                                                  | 480  | 514   | 19·0                 |
| 12             | 1          | 864                                                                                                                | 812  | 846   | 11·8                 | 949                                                                                                                  | 909  | 929   | 11·4                 | 943                                                                                                                  | 912  | 931   | 10·7                 |
| 18             | 2          | 1222                                                                                                               | 1137 | 1186  | 19·7                 | 1318                                                                                                                 | 1261 | 1283  | 13·1                 | 1292                                                                                                                 | 1229 | 1265  | 11·7                 |
| 18             | 3          | 1536                                                                                                               | 1454 | 1492  | 18·6                 | 1655                                                                                                                 | 1601 | 1627  | 15·6                 | 1618                                                                                                                 | 1550 | 1598  | 12·9                 |
| 18             | 4          | 1803                                                                                                               | 1741 | 1770  | 17·9                 | 2017                                                                                                                 | 1948 | 1992  | 15·7                 | 1951                                                                                                                 | 1884 | 1923  | 15·9                 |
| 18             | 5          | 2175                                                                                                               | 2054 | 2115  | 28·1                 | 2364                                                                                                                 | 2295 | 2330  | 22·8                 | 2270                                                                                                                 | 2170 | 2230  | 23·1                 |
| *20            | 5          | 1901                                                                                                               | 1802 | 1848  | 25·9                 | 2241                                                                                                                 | 2175 | 2211  | 16·0                 | 1967                                                                                                                 | 1892 | 1925  | 18·7                 |
| 18             | 6          | 2448                                                                                                               | 2338 | 2384  | 27·9                 | 2704                                                                                                                 | 2637 | 2665  | 17·8                 | 2602                                                                                                                 | 2488 | 2564  | 20·6                 |
| 18             | 7          | 2730                                                                                                               | 2628 | 2684  | 27·2                 | 3070                                                                                                                 | 2989 | 3023  | 24·6                 | 2890                                                                                                                 | 2811 | 2855  | 18·4                 |
| 18             | 8          | 3015                                                                                                               | 2923 | 2975  | 21·4                 | 3360                                                                                                                 | 3266 | 3325  | 19·0                 | 3150                                                                                                                 | 3032 | 3099  | 20·8                 |
| 18             | 9          | 3272                                                                                                               | 3156 | 3224  | 23·0                 | 3698                                                                                                                 | 3607 | 3655  | 20·5                 | 3406                                                                                                                 | 3262 | 3327  | 27·1                 |
| 18             | 10         | 3510                                                                                                               | 3431 | 3460  | 19·0                 | 3963                                                                                                                 | 3883 | 3918  | 20·1                 | 3609                                                                                                                 | 3414 | 3524  | 32·7                 |
| 9              | 15         | 4776                                                                                                               | 4654 | 4710  | 32·0                 | 5752                                                                                                                 | 5563 | 5665  | 53·8                 | 4780                                                                                                                 | 4604 | 4719  | 45·1                 |
| 9              | 25         | 6090                                                                                                               | 5910 | 5988  | 54·9                 | 7725                                                                                                                 | 7453 | 7522  | 55·3                 | 6086                                                                                                                 | 5880 | 5981  | 49·5                 |
| 9              | 33         | 6915                                                                                                               | 6610 | 6788  | 75·9                 | 8898                                                                                                                 | 8690 | 8776  | 75·1                 | 6932                                                                                                                 | 6630 | 6774  | 68·0                 |

\* This result was obtained after the guns had fired 2,800 rounds.

NOTE.—The M. L. Armstrong gun used a wad composed of junk and stearine in the practice at 0°, 15°, 25° and 33°, and also at 5° after 2,800 rounds; neither wad nor lubrication was used at the other elevations with this gun.

The other guns used Boxer's lubricators, the Whitworth being filled with oil.

From this Table the relative range of the various guns with solid shot may be stated as follows, the elevation corresponding to the per-centage indicating the increase of elevation that the inferior range gun must receive above that of the superior in order to obtain the same range.

| ELEVATION. | WHITWORTH.                                                                                                                                                             | M. L. ARMSTRONG.                                                                |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| 0          | 8 per cent. superior to the B. L. Armstrong.<br>Corresponding to 6' elevation.                                                                                         | Equal to the Whitworth.                                                         |
| 1          | 9 per cent. superior to the B. L. Armstrong.<br>Corresponding to 13' elevation.                                                                                        | Equal to the Whitworth.                                                         |
| 3          | 9 per cent. superior to the B. L. Armstrong.<br>Corresponding to 27' elevation.<br>2 per cent. superior to the M. L. Armstrong.<br>Corresponding to 5' elevation.      | 7 per cent. superior to the B. L. Armstrong.<br>Corresponding to 21' elevation. |
| 5          | 9 per cent. superior to the B. L. Armstrong.<br>Corresponding to 42' elevation.<br>4 per cent. superior to the M. L. Armstrong.<br>Corresponding to 18' elevation.     | 5 per cent. superior to the B. L. Armstrong.<br>Corresponding to 22' elevation. |
| 7          | 12 per cent. superior to the B. L. Armstrong.<br>Corresponding to 1° 9' elevation.<br>6 per cent. superior to the M. L. Armstrong.<br>Corresponding to 37' elevation.  | 6 per cent. superior to the B. L. Armstrong.<br>Corresponding to 35' elevation. |
| 10         | 13 per cent. superior to the B. L. Armstrong.<br>Corresponding to 1° 56' elevation.<br>11 per cent. superior to the M. L. Armstrong.<br>Corresponding to 2° elevation. | 2 per cent. superior to the B. L. Armstrong.<br>Corresponding to 16' elevation. |
| 15         | 20 per cent. superior to the B. L. and M. L. Armstrong.<br>Corresponding to about 3° 50' elevation.                                                                    | Same range as the B. L. Armstrong.                                              |
| 25         | 25 per cent. superior to the B. L. and M. L. Armstrong. Unattainable with either gun.                                                                                  | Same range as the B. L. Armstrong.                                              |
| 33         | 29 per cent. superior to the B. L. and M. L. Armstrong. Unattainable with either gun.                                                                                  | Same range as the B. L. Armstrong.                                              |



The Committee desire particularly to direct attention to the fact which appears from the preceding Table of Ranges, that in the case of each of the three guns the ranges obtained at 5° of elevation, after they had been fired 2,800 rounds, were considerably less than when the guns were comparatively new, and had fired but few rounds.

In the case of the breech-loading Armstrong gun, the range had diminished from 2,115 to 1,848 yards, or 13 per cent., corresponding to 43' elevation. Diminution of range.

In the case of the Whitworth gun, the range had diminished from 2,330 to 2,211 yards, or 5 per cent., corresponding to 21' elevation.

In the case of the muzzle-loading Armstrong or shunt gun, the range had diminished from 2,230 to 1,925 yards, or 14 per cent., corresponding to 1° of elevation, the range being precisely the same with 5° as it had been when fired at the commencement of the experiments with 4° of elevation.

The bores of all the guns had become enlarged during the course of the experiments ; that of the breech-loading Armstrong from .029 to .036 inches in front of the shot chamber, that of the Whitworth gun .005 inch, and that of the muzzle-loading Armstrong gun .003 inch. Inspector of Ordnance's Report, p. 231, App.

In firing the 2,800 rounds, the bore of the breech-loading Armstrong had not been scored by the escape of gas over the shot, whereas the bore of the Whitworth gun was slightly scored, and that of the muzzle-loading Armstrong or shunt gun was very much scored all round and in the grooves.

The Committee consider that this loss in range is to be accounted for by the escape of gas consequent on the enlargement of the bore in the breech-loading gun, and to that cause combined with scoring in the muzzle-loading guns ; and that these causes are probably sufficient to account for the difference of loss in the several guns.

It appears also that the sums of the ratios of the mean errors in the ranges of the respective guns are as follows :—

|                          |   |   |   |       |
|--------------------------|---|---|---|-------|
| Breech-loading Armstrong | - | - | - | 19.3  |
| Whitworth                | - | - | - | 16.67 |
| Muzzle-loading Armstrong | - | - | - | 18.8  |

A comparison of these figures shows that the Whitworth gun is rather more uniform in its range than the other two guns, and that the muzzle-loading Armstrong is rather more uniform than the breech-loading Armstrong gun.

The following abstract shows the general result of this practice with segment and shrapnel \* after elimination by the competitors of a per-centage of the most unfavourable rounds :—

SEGMENT OR SHRAPNEL SHELL.

| Elevation. | No. of Rounds. | Armstrong B. L. 12-Pr.<br>Projectile Segment Shell 11.6 lb.<br>Charge of powder . . . 1.5 lb. |      |       |                      | Whitworth 12-Pr.<br>Projectile Shrapnel Shell 11.8 lb.<br>Charge of powder . . . 1.75 lb. |      |       |                      | Armstrong 12-Pr. M. L.<br>Projectile Segment Shell 11.6 lb.<br>Charge of powder . . . 1.75 lb. |      |       |                      |
|------------|----------------|-----------------------------------------------------------------------------------------------|------|-------|----------------------|-------------------------------------------------------------------------------------------|------|-------|----------------------|------------------------------------------------------------------------------------------------|------|-------|----------------------|
|            |                | Range in yards.                                                                               |      |       |                      | Range in yards.                                                                           |      |       |                      | Range in yards.                                                                                |      |       |                      |
|            |                | Max.                                                                                          | Min. | Mean. | Mean error in range. | Max.                                                                                      | Min. | Mean. | Mean error in range. | Max.                                                                                           | Min. | Mean. | Mean error in range. |
|            |                |                                                                                               |      |       | yards.               |                                                                                           |      |       | yards.               |                                                                                                |      |       | yards.               |
| 0°         | 16             | 534                                                                                           | 465  | 505   | 16.0                 | 558                                                                                       | 508  | 525   | 12.5                 | 595                                                                                            | 547  | 568   | 12.7                 |
| 3°         | 18             | 1487                                                                                          | 1421 | 1445  | 15.3                 | 1606                                                                                      | 1509 | 1558  | 24.1                 | 1651                                                                                           | 1530 | 1607  | 26.5                 |
| 5°         | 17             | 2147                                                                                          | 2022 | 2080  | 31.2                 | 2316                                                                                      | 2182 | 2264  | 22.0                 | 2351                                                                                           | 2223 | 2277  | 31.5                 |
| 7°         | 17             | 2732                                                                                          | 2571 | 2644  | 34.9                 | 2990                                                                                      | 2789 | 2897  | 36.5                 | 2916                                                                                           | 2690 | 2798  | 57.8                 |
| 10°        | 15             | 3454                                                                                          | 3142 | 3306  | 87.0                 | 3848                                                                                      | 3501 | 3700  | 81.6                 | 3721                                                                                           | 3462 | 3600  | 71.1                 |

\* NOTE.—The shell proposed by Sir W. Armstrong is called the Segment Shell, that proposed by Col. Boxer, R.A., and fired from Mr. Whitworth's gun, is called a Shrapnel Shell, being filled with musket balls. A junk and stearine wad was used throughout this practice with the M. L. Armstrong gun. The other guns used Boxer's lubricators, that for the Whitworth gun being filled with oil.

From this Table the relative range of the various guns with segment and shrapnel shell may be stated as follows, the elevation corresponding to the per-centage indicating the increase of elevation that the inferior gun must receive above that of the superior in order to obtain the same range:—

| ELEVATION. | WHITWORTH.                                                                                                                                                             | M. L. ARMSTRONG.                                                                                                                                             |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0°         | 4 per cent. superior to the B. L. Armstrong.<br>Corresponding to about 3' elevation.                                                                                   | 8 per cent. superior to the Whitworth.<br>Corresponding to 7' elevation.<br>12 per cent. superior to the B. L. Armstrong.<br>Corresponding to 12' elevation. |
| 3°         | 7 per cent. superior to the B. L. Armstrong.<br>Corresponding to about 21' elevation.                                                                                  | 3 per cent. superior to the Whitworth.<br>Corresponding to 8' elevation.<br>11 per cent. superior to the B. L. Armstrong.<br>Corresponding to 25' elevation. |
| 5°         | 8 per cent. superior to the B. L. Armstrong.<br>Corresponding to 39' elevation.                                                                                        | Equal to Whitworth.                                                                                                                                          |
| 7°         | 9 per cent. superior to the B. L. Armstrong.<br>Corresponding to 1° 8'.<br>3 per cent. superior to the M. L. Armstrong.<br>Corresponding to 22' elevation.             | 5 per cent. superior to the B. L. Armstrong.<br>Corresponding to 42' elevation.                                                                              |
| 10°        | 11 per cent. superior to the B. L. Armstrong.<br>Corresponding to 1° 46' elevation.<br>2 per cent. superior to the M. L. Armstrong.<br>Corresponding to 22' elevation. | 8 per cent. superior to the B. L. Armstrong.<br>Corresponding to 1° 19' elevation.                                                                           |

It appears also that the sums of the ratios of the mean errors in the ranges of the respective guns are as follow:—

|                          |   |   |      |
|--------------------------|---|---|------|
| Breech-loading Armstrong | - | - | 5.92 |
| Whitworth                | - | - | 5.76 |
| Muzzle-loading Armstrong | - | - | 6.82 |

A comparison of these figures shows that the Whitworth gun is rather more uniform in its range than the other two guns, and that the B. L. Armstrong, is rather more uniform than the M. L. Armstrong gun.

The Committee observe from these Tables, that although in all cases there is a slight increase of range at low elevations with these projectiles as compared with solid shot, the range with the breech-loading Armstrong and Whitworth falls off at higher elevations, and at 5° the Whitworth and muzzle-loading Armstrong guns are on a par.

### INITIAL VELOCITY AND RETARDATION.

A series of experiments to determine the initial velocity and retardation of the 12-pounders was carried on for the Committee by Lieut. Noble, Royal Artillery, with the electro-ballistic apparatus invented by Major Navez of the Belgian Artillery.

Two instruments were simultaneously employed, by which the velocity of each projectile was determined at two points in its trajectory, one near the muzzle of the gun, and the other at a considerable distance from it.

The velocity lost in passing over the intermediate space was thus ascertained, and the experiments were continued until five good observations were obtained with each nature of projectile.

The details of these experiments will be found in the Appendix.

The general results are summed up in the following Table:—

#### 12-POUNDERS.

| Nature of Gun.    | Projectile.    |         | Charge. | Observed Velocity at |              |              | Observed Loss of Velocity in |          | Calculated mean initial Velocity. |
|-------------------|----------------|---------|---------|----------------------|--------------|--------------|------------------------------|----------|-----------------------------------|
|                   | Nature.        | Weight. |         | 40 yds.              | 440 yds.     | 840 yds.     | 400 yds.                     | 800 yds. |                                   |
|                   |                | lbs.    | lbs.    | ft. per sec.         | ft. per sec. | ft. per sec. | feet.                        | feet.    |                                   |
| B. L. Armstrong - | Solid shot -   | 11.56   | 1.5     | 1233.3               | 1107.9       | 1042.6       | 120.7                        | 190.7    | 1246.6                            |
| Whitworth -       | Solid shot -   | 11.87   | 1.75    | 1270.9               | 1163.5       | 1094.3       | 112.7                        | 176.6    | 1283.3                            |
| M. L. Armstrong - | Solid shot -   | 11.56   | 1.75    | 1341.0               | 1185.4       | 1093.5       | 157.0                        | 247.5    | 1356.2                            |
| B. L. Armstrong - | Segment shell  | 11.66   | 1.5     | 1235.3               | —            | 1045.5       | —                            | 189.8    | 1248.6                            |
| Whitworth -       | Shrapnel shell | 12.06   | 1.75    | 1245.9               | —            | 1091.0       | —                            | 155.0    | 1257.9                            |
| M. L. Armstrong - | Segment shell  | 11.56   | 1.75    | 1341.0               | —            | 1093.5       | —                            | 247.5    | 1356.2                            |
| B. L. Armstrong - | Common shell   | 11.75   | 1.5     | 1225.5               | —            | 1040.8       | —                            | 184.7    | 1238.8                            |
| Whitworth -       | Common shell   | 11.75   | 1.75    | 1265.5               | —            | 1100.2       | —                            | 165.3    | 1277.9                            |
| M. L. Armstrong - | Common shell   | 11.75   | 1.75    | 1343.4               | —            | 1104.5       | —                            | 238.9    | 1358.5                            |
| B. L. Armstrong - | Common shell   | 11.75   | 1.75    | 1309.1               | —            | —            | —                            | —        | 1319.5                            |



From these experiments it appears that with the service charges the initial velocities of the breech-loading Armstrong and the Whitworth guns are nearly equal, the Whitworth gun having only a slight advantage, whereas the initial velocity of the muzzle-loading Armstrong gun is, with the segment shell, 100 feet per second greater than the Whitworth with the shrapnel shell, and nearly as much greater with the other projectiles. The retardation of the Whitworth projectiles is, however, considerably less than that with the breech-loading Armstrong projectiles, which again is less than that with the muzzle-loading Armstrong projectiles; so that after a flight of 840 yards the velocities of the projectiles fired from the Whitworth and muzzle-loading Armstrong guns are equal, and in both cases superior to those fired from the breech-loading Armstrong gun, thus fully corroborating the results obtained from the trials for range.

In an experiment in which the breech-loading Armstrong gun was fired with a charge of powder weighing 1.75 lbs., being the same as that used with the Whitworth and muzzle-loading Armstrong guns, the initial velocity of the projectile was 39 feet per second less than that obtained with the muzzle-loading Armstrong, and 41.6 feet per second greater than that obtained with the Whitworth gun.

ACCURACY.

The trials for accuracy were in the first instance carried on against deal targets, one for each gun, 9 feet square, at ranges varying from 200 to 1,300 yards, and at ranges exceeding 1,300 yards at three targets of the same size for each gun.

At the request of the competitors the guns were either laid by themselves, or by persons nominated by them for the purpose, at bull's-eyes 12 inches in diameter, from the centre of which the measurements were taken; five trial shots, which were not recorded, being allowed for each gun at each range, for the purpose of ascertaining the elevation and deflection at which the guns should be laid.

The records of this practice are given in the Appendix.

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291, 333.

The Committee experienced much difficulty in determining the accuracy of the guns from these experiments, in consequence of its being dependent on the skill and judgment of the men who laid the guns; in order, however, as much as possible to prevent any inequality in the practice of the rival guns, the Committee selected an officer to look over each gun after it had been laid by the competitors, to point out any errors in the laying.

At ranges not exceeding 900 yards, the hits on the targets give a fair record of the practice with the respective guns; the results are shown in the following Tables, in which the mean radial distance in inches of the shots from the centre is given, as ascertained from all the targets on which all the shots were recorded as hits:—

SOLID SHOT.

| Nature of Gun.    | Mean Radial Distance obtained from 5 rounds at |          |          |          |          |          |          |          |
|-------------------|------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|
|                   | 200 yds.                                       | 300 yds. | 400 yds. | 500 yds. | 600 yds. | 700 yds. | 800 yds. | 900 yds. |
| 12-Pr.            | Inches.                                        | Inches.  | Inches.  | Inches.  | Inches.  | Inches.  | Inches.  | Inches.  |
| B. L. Armstrong - | 11.65                                          | 14.9     | 20.95    | 27.5     | —        | —        | 37.55    | 29.8     |
| Whitworth -       | 5.8                                            | 4.7      | 17.1     | 21.2     | 29.3     | —        | 34.9     | —        |
| M. L. Armstrong - | 7.15                                           | 10.45    | 14.2     | 18.1     | 26.95    | —        | 31.45    | —        |
| COMMON SHELL.     |                                                |          |          |          |          |          |          |          |
| B. L. Armstrong - | —                                              | 16.0*    | —        | —        | —        | 45.3     | —        | —        |
| Whitworth -       | —                                              | 15.1*    | —        | —        | —        | —        | —        | —        |
| M. L. Armstrong - | —                                              | 7.6*     | —        | —        | —        | 26.9     | —        | —        |

\* This practice was carried on after 200 rounds rapid firing.

It being exceedingly difficult to employ targets for practice at longer ranges than 900 yards of such dimensions as would catch all the shot, and thus ensure a complete record of the practice, and it having been found impossible, on account of the difficulty of assigning an exact value to a miss, to make a comparison of the accuracy of the various guns without a record of the position of every shot, the Committee decided to test the relative accuracy of the guns by the same series of experiments by which their range was determined.

In these experiments the guns were placed in battery as nearly as possible under like conditions, and were laid by spirit level.

The position in which each shot fell on the sands was carefully noted.

The competitors were then allowed to strike out a per-centage of the shot from the records, the remainder of which then formed a group.

These groups have been arranged in parallelograms calculated upon the law of probabilities according to the method usually adopted. The Committee, however, have not been satisfied with this expression of the practice of the guns as a representation of their comparative accuracy, but in order that their accuracy, when fired at vertical targets, might be compared (that being the condition under which rifled guns are usually fired on service), the Committee have, by a simple calculation, which is sufficiently accurate for all practical purposes, based on the angle of descent of the projectiles, transferred the positions at which the shot struck on the horizontal plane of the sands to a vertical plane at the mean range of the group.

By this means the horizontal target is, as it were, converted into a vertical target, on which the position of every shot may be recorded, and its radial distance ascertained, from the centre of the group.

Practically, however, it is found to be a matter of great labour and an unnecessary refinement to calculate the position of each shot; therefore, when the number of rounds has been small (under 20), the sums of all the errors in range and deflection have been used, in combination with the angle of descent at the mean range, to calculate the mean radial distance of the shot on the vertical target; and when a greater number of rounds have been fired, two or more radial distances have been calculated separately, and a mean afterwards obtained from them.

This gives a very close approximation to the more correct plan of working out the radial distance of each shot separately.

The following Table exhibits the mean ranges and the mean radial distances, for solid shot, as derived from these calculations.

| 12-Pr. ARMSTRONG B. L. |                |        |                  | 12-Pr. WHITWORTH. |                |        |                  | 12-Pr. ARMSTRONG M. L. |                |        |                  |
|------------------------|----------------|--------|------------------|-------------------|----------------|--------|------------------|------------------------|----------------|--------|------------------|
| Elevation.             | No. of Rounds. | Range. | Radial Distance. | Elevation.        | No. of Rounds. | Range. | Radial Distance. | Elevation.             | No. of Rounds. | Range. | Radial Distance. |
| °                      |                | yards. | inches.          | °                 |                | yards. | inches.          | °                      |                | yards. | inches.          |
| 0                      | 6              | 503    | 14               | 0                 | 6              | 508    | 11               | 0                      | 6              | 519    | 11               |
| 0                      | 18             | 466    | 21               | 0                 | 18             | 506    | 7                | 0                      | 18             | 514    | 17               |
| 1                      | 5              | 867    | 29               | 1                 | 5              | 914    | 35               | 1                      | 5              | 905    | 24               |
| 1                      | 12             | 846    | 40               | 1                 | 12             | 929    | 20               | 1                      | 12             | 931    | 16               |
| 2                      | 18             | 1186   | 54               | 2                 | 18             | 1283   | 33               | 2                      | 18             | 1265   | 39               |
| 3                      | 18             | 1492   | 60               | 3                 | 18             | 1627   | 46               | 3                      | 18             | 1598   | 63               |
| 4                      | 18             | 1770   | 70               | 4                 | 18             | 1992   | 59               | 4                      | 18             | 1923   | 65               |
| 5                      | 18             | 2115   | 131              | 5                 | 18             | 2330   | 101              | 5                      | 18             | 2230   | 114              |
| *5                     | 20             | 1848   | 112              | 5                 | 20             | 2211   | 101              | 5                      | 20             | 1925   | 95               |
| 6                      | 18             | 2384   | 162              | 6                 | 18             | 2665   | 95               | 6                      | 18             | 2564   | 118              |
| 7                      | 18             | 2684   | 165              | 7                 | 18             | 3023   | 154              | 7                      | 18             | 2855   | 140              |
| 8                      | 18             | 2975   | 166              | 8                 | 18             | 3325   | 140              | 8                      | 18             | 3099   | 185              |
| 9                      | 18             | 3224   | 208              | 9                 | 18             | 3655   | 158              | 9                      | 18             | 3327   | 251              |
| 10                     | 18             | 3460   | 191              | 10                | 18             | 3918   | 192              | 10                     | 18             | 3524   | 363              |
|                        |                |        |                  | 5                 | 20             | 2355   | 135              | 5                      | 20             | 2144   | 119†             |

\* This result was obtained after the guns had fired 2,800 rounds.

† This result was obtained without lubricator or wad of any kind.

NOTE.—The B. L. Armstrong and Whitworth used Boxer's lubricators, that for the Whitworth gun being filled with oil. The M. L. Armstrong used neither wad nor lubrication except in the practice at 0° and in that at 5° after 2,800 rounds, when a junk and stearine wad was used.

From an inspection of the above Table, it is evident, that the mean radial distances represent the relative accuracy of the guns, when laid at the stated elevations at the respective ranges for those elevations, which in all cases are different.

Now it is evident that the greater the range of a gun, the greater becomes the divergence of its projectile from the line passing through the axis of the gun and the centre of the group; and *vice versâ*.

To obtain, therefore, a more just comparison for accuracy from the results of the practice as given in the preceding Table, it is necessary to select such ranges with the different guns as are so similar as to be practically equal.



This has been done in the following Table, in which unity has been assigned as the figure of merit to the most accurate shooting gun at each range, and the other guns have been assigned figures of merit proportionate to the mean radial distances of their shot from the centres of their groups, as given in the preceding Tables.

## 12-PR. SOLID SHOT.

| Ranges.          |            |                  | Comparative Accuracy at the specified Ranges. |            |                  |
|------------------|------------|------------------|-----------------------------------------------|------------|------------------|
| B. L. Armstrong. | Whitworth. | M. L. Armstrong. | B. L. Armstrong.                              | Whitworth. | M. L. Armstrong. |
| yards.           | yards.     | yards.           |                                               |            |                  |
| 503              | 508        | 519              | 1·3                                           | 1·0        | 1·0              |
| 466              | 506        | 514              | 3·0                                           | 1·0        | 2·4              |
| 867              | 914        | 905              | 1·2                                           | 1·4        | 1·0              |
| 846              | 929        | 1931             | 2·5                                           | 1·2        | 1·0              |
| 1186             | 1283       | 1265             | 1·6                                           | 1·0        | 1·2              |
| 1492             | 1627       | 1598             | 1·3                                           | 1·0        | 1·3              |
| 2115             | 1992       | 2923             | 2·2                                           | 1·0        | 1·1              |
| 2384             | 2330       | 2230             | 1·6                                           | 1·0        | 1·1              |
| 2684             | 2665       | 3564             | 1·7                                           | 1·0        | 1·2              |
| 2975             | 3023       | 3099             | 1·1                                           | 1·0        | 1·2              |
| 3224             | 3325       | 3327             | 1·4                                           | 1·0        | 1·8              |
|                  | 3655       | 3524             |                                               | 1·0        | 2·3              |

From this Table the following results are apparent :—

| Range.                                | 12-Pounder Whitworth.                                                                                    | 12-Pounder Muzzle-loading Armstrong.               |
|---------------------------------------|----------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| Up to 900 yards, 41 rounds            | 73 per cent. superior to breech-loading Armstrong.<br>17 per cent. superior to muzzle-loading Armstrong. | 48 per cent. superior to breech-loading Armstrong. |
| From 900 to 2,000 yards, 54 rounds.   | 70 per cent. superior to breech-loading Armstrong.<br>20 per cent. superior to muzzle-loading Armstrong. | 41 per cent. superior to breech-loading Armstrong. |
| From 2,000 to 3,000 yards, 54 rounds. | 46 per cent. superior to breech-loading Armstrong.<br>16 per cent. superior to muzzle-loading Armstrong. | 25 per cent. superior to breech-loading Armstrong. |
| From 3,000 to 3,600 yards, 36 rounds. | 100 per cent. superior to muzzle-loading Armstrong.                                                      |                                                    |

The advantage of the Whitworth gun in respect of accuracy with solid shot, as compared with the breech-loading Armstrong gun, is very marked throughout.

The accuracy of the Whitworth gun, with solid shot, is greater than that of the muzzle-loading Armstrong gun in most cases; this is so in a very marked degree at ranges beyond 3,000 yards.

The muzzle-loading Armstrong gun has a marked superiority over the breech-loading Armstrong gun at ranges up to 3,000 yards, beyond which a comparison cannot be made in consequence of the breech-loading Armstrong not having acquired a range of 3,600 yards with the elevations embraced in the Committee's experiments.

In order to test the accuracy of the respective guns with segment and shrapnel shell, which, as regards field guns, are of more importance than solid shot, the latter projectile not being at present used with rifled field pieces, the Committee at first decided on firing five rounds with these projectiles at each range up to 10°, expecting from their similarity of form that the results would have accorded with those obtained from firing solid shot, and the expense of firing a great number of rounds of segment and shrapnel shell would have been avoided. Subsequently, however, as the practice from these few rounds clearly indicated that the range and accuracy with these projectiles was very different from those obtained with solid shot, and the Committee considering, that alone, they were not sufficient to give reliable results, they caused some additional practice to be carried on with these projectiles at 0°, 3°, 5°, 7°, and 10° of elevation.

In the following Table, which is deduced from this practice, the details of which are to be found in the Appendix, the mean radial distances of the shell are given as calculated, in the same way, as has been done with the solid shot.

## SEGMENT AND SHRAPNEL SHELL.

| B.L. 12-Pr. ARMSTRONG. |               |        |                  | 12-Pr. WHITWORTH. |                  | M.L. 12-Pr. ARMSTRONG. |                  |
|------------------------|---------------|--------|------------------|-------------------|------------------|------------------------|------------------|
| Elevation.             | No. o Rounds. | Range. | Radial Distance. | Range.            | Radial Distance. | Range.                 | Radial Distance. |
| °                      |               | yards. | Inches.          | yards.            | Inches.          | yards.                 | Inches.          |
| 0                      | 16            | 505    | 29               | 525               | 24               | 568                    | 15               |
| 3                      | 18            | 1445   | 54               | 1558              | 83               | 1607                   | 110              |
| 5                      | 17            | 2080   | 147              | 2264              | 138              | 2277                   | 165              |
| 7                      | 17            | 2644   | 264              | 2897              | 245              | 2798                   | 376              |
| 10                     | 15            | 3306   | 821              | 3700              | 712              | 3600                   | 608              |

NOTE.—The B. L. Armstrong and Whitworth used Boxer's lubricator, the M. L. Armstrong a junk and stearine wad.

From the above Table the following results are apparent :—

| Range.                       |   | Whitworth.                                   | M. L. Armstrong.                            |
|------------------------------|---|----------------------------------------------|---------------------------------------------|
| Up to 2,000 yards, 51 rounds | - | 2 per cent. inferior to the B.L. Armstrong.  | 5 per cent. inferior to the B.L. Armstrong. |
| Up to 3,700 yards, 32 rounds | - | 13 per cent. superior to the M.L. Armstrong. |                                             |

Hence it appears that all three guns may be considered as practically equal as regards accuracy with segment or shrapnel shell up to elevations of 5°, giving ranges of about 2,000 yards. As the competitors submitted common shell for use with these guns, the Committee caused five rounds to be fired from each gun at each degree of elevation up to 10°. The results are given in the following Table.

## COMMON SHELL.

| Elevation. | No. of Rounds. | B.L. ARMSTRONG. |                  | WHITWORTH. |                  | M.L. ARMSTRONG.* |                  |
|------------|----------------|-----------------|------------------|------------|------------------|------------------|------------------|
|            |                | Range.          | Radial Distance. | Range.     | Radial Distance. | Range.           | Radial Distance. |
| °          |                | Yards.          | Inches.          | Yards.     | Inches.          | Yards.           | Inches.          |
| 0          | 4              | 505             | 10               | 540        | 6                | 533              | 11               |
| 1          | 4              | 874             | 17               | 934        | 20               | 913              | 15               |
| 2          | 4              | 1188            | 37               | 1277       | 24               | 1301             | 23               |
| 3          | 4              | 1487            | 46               | 1628       | 36               | 1603             | 53               |
| 4          | 4              | 1740            | 100              | 1970       | 99               | 1952             | 29               |
| 5          | 4              | 2042            | 73               | 2201       | 173              | 2216             | 72               |
| 6          | 4              | 2320            | 84               | 2662       | 131              | 2587             | 94               |
| 7          | 4              | 2633            | 102              | 3021       | 256              | 2888             | 67               |
| 8          | 4              | 2874            | 110              | 3267       | 103              | 3066             | 382              |
| 9          | 4              | 3128            | 159              | 3614       | 474              | 3349             | 90               |
| 10         | 4              | 3302            | 295              | 3862       | 348              | 3523             | 270              |

From this Table the relative accuracy at nearly equal ranges may be stated as in the following Table.

| Ranges.         |            |                 | Comparative Accuracy. |            |                 |
|-----------------|------------|-----------------|-----------------------|------------|-----------------|
| B.L. Armstrong. | Whitworth. | M.L. Armstrong. | B.L. Armstrong.       | Whitworth. | M.L. Armstrong. |
| yards.          | yards.     | yards.          |                       |            |                 |
| 505             | 540        | 533             | 1·7                   | 1·0        | 1·8             |
| 874             | 934        | 913             | 1·1                   | 1·3        | 1·0             |
| 1188            | 1277       | 1301            | 1·6                   | 1·0        | 1·0             |
| 1487            | 1628       | 1603            | 1·2                   | 1·0        | 1·4             |
| 2042            | 1970       | 1952            | 2·5                   | 3·4        | 1·0             |
| 2320            | 2201       | 2216            | 1·1                   | 2·4        | 1·0             |
| 2633            | 2662       | 2587            | 1·1                   | 1·4        | 1·0             |
| 2874            | 3021       | 3066            | 1·0                   | 2·3        | 3·4             |
| 3302            | 3267       | 3349            | 3·2                   | 1·1        | 1·0             |
| —               | 3614       | 3523            | —                     | 1·8        | 1·0             |

\* The B. L. Armstrong and Whitworth used Boxer's lubricators, the M. L. Armstrong used neither wad nor lubricator.



From the above Table the following results are apparent :—

| Range.                    | Whitworth.                                              | M. L. Armstrong.                                                                         |
|---------------------------|---------------------------------------------------------|------------------------------------------------------------------------------------------|
| Up to 900 yards - -       | 21 per cent. superior to the B. L. and M. L. Armstrong. | Equal to the B. L. Armstrong.                                                            |
| From 900 to 2,000 yards - | 2 per cent. inferior to the B. L. Armstrong.            | 56 per cent. superior to the B. L. Armstrong.<br>58 per cent. superior to the Whitworth. |
| From 2,000 to 3,300 yards | 12 per cent. inferior to the B. L. Armstrong.           | 12 per cent. superior to the Whitworth.<br>Equal to the B. L.                            |

The number of rounds fired at each elevation with these projectiles was so small that the Committee do not consider the results to be of the same value as if obtained from a larger number of rounds. The Committee, however, did not deem it necessary or desirable to repeat the practice, being of opinion that this projectile would very rarely be used with 12-pounder guns on actual service.

### PENETRATION.

The Committee tested the powers of penetration of the 12-pounders by firing solid shot, common and segment shells, against stockades formed of fresh-felled rough-hewn elm logs, 14 inches in thickness, flatted on their opposite sides, placed side by side, and sunk four feet into the ground, and against walls 28 inches in thickness, built of the best stock bricks laid in cement.

In all cases the force of the projectiles was sufficient up to the maximum range (1,300 yards) at which they were tried, to penetrate the objects fired at, which may be taken as fairly representing the defences usually made use of in field operations; but as field guns are very rarely used on service in cases in which extreme penetration is an object, the Committee did not think it necessary to try experiments to ascertain it.

### EASE OF WORKING.

Throughout the long course of experiments conducted by the Committee, their attention has been constantly directed to the observation of the relative ease of working of the competitive guns, the importance of which is so great that they have tested it by repeated special experiments of rapid and prolonged firing.

The guns in each case were placed in battery side by side, and every endeavour was made both in determining their position and in telling off and changing the gun detachments to prevent any advantage accruing to one gun in preference to another.

The times in which the given number of rounds were fired by each gun were then carefully taken.

The record of these experiments is to be found in the Appendix, the following being a summary :—

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| Description of Gun. | 19th April.    |           | 19th May.      |           | 1st June.      |           | 10th November.<br>(without Lubrication). |           |
|---------------------|----------------|-----------|----------------|-----------|----------------|-----------|------------------------------------------|-----------|
|                     | No. of Rounds. | Time.     | No. of Rounds. | Time.     | No. of Rounds. | Time.     | No. of Rounds.                           | Time.     |
|                     |                | min. sec. |                | min. sec. |                | min. sec. |                                          | min. sec. |
| B. L. Armstrong -   | 200            | 80 0      | 99             | 51 21     | 98 *           | 35 34     | Practice not completed.                  |           |
| Whitworth - -       | 200            | 72 0      | 99             | 59 0      | 98 †           | 33 24     |                                          |           |
| M. L. Armstrong -   | 200            | 81 0      | 99             | 57 39     | 98 ‡           | 37 14     | 86                                       | 28 0      |

\* Neither oil nor water used.

† Trifling delay caused by priming wire sticking.

‡ Several trifling delays caused by platform shifting.

In the experiments made on the 19th April water was frequently applied, and oil occasionally to the breech screw of the breech-loading Armstrong gun, after the 43rd round. At the 84th round the breech screw stuck, and required considerable force to move it, the delay, however, was trifling. Sir William Armstrong afterwards discovered that this

delay was caused by the burring of the tappet ring by the upper keep pin, which was therefore removed for the remainder of the Committee's experiments.

In the experiments with the muzzle-loading Armstrong gun, unnecessary delay arose from the cartridges being too high gauge. Several had to be rejected on the 19th April, as they would not enter the gun, and one on the 19th May; the wads also had not been attached to the cartridges as in the case of the other guns, and had to be entered separately.

The vent pieces of the breech-loading Armstrong gun were frequently changed, according to custom, when they became heated; three were used in the experiment.

In addition to the above experiments, 100 rounds were, in accordance with the wish of Sir W. Armstrong, fired from his breech-loading gun by a carefully selected detachment, who served the gun with a detail of duties different from that prescribed in the drill instructions, by which Sir W. Armstrong considered that unnecessary time was lost.

In the drill, as laid down for the service of these guns, it is prescribed that the man who works the vent piece should also prime and fire. The performance of these several duties has been imposed on the same man to prevent the risk of the gun being fired before the breech is perfectly closed, but it was found, in the experiments made by the Committee, that these duties were very heavy for one man to perform, and caused delays; hence Sir William Armstrong desired that the experiments should be repeated with a different detail, by which the duties of priming and firing should devolve upon one number, whilst another should work the vent piece.

The result of this experiment was, that without the application of either oil or water to the breech screw, 50 rounds were fired in the exceeding short space of 6 minutes and 59 seconds, and 50 more rounds in 6 minutes and 39 seconds.

The Committee observe, however, that this practice was made by a detachment of experienced gunners selected from the experimental department at Shoeburyness, and although the feat was performed with safety and dexterity, the firing was so rapid as to preclude the proper laying of the gun. The Committee further consider that this experiment would have been attended with risk, and especially so, if performed in the heat of action with ordinary gunners.

The Committee also tested the relative ease of working these 12-pounders when employed for sea service as boat guns.

The several guns having been mounted on compressor carriages in the bows of three pinnaces, 10 rounds were fired from each, the boats having slight but rapid, rolling, pitching, and yawing motions.

The average times of each round were as follows:—

|                          |   |   |               |
|--------------------------|---|---|---------------|
| Breech-loading Armstrong | - | - | 59.5 seconds. |
| Whitworth                | - | - | 90    "       |
| Muzzle-loading Armstrong | - | - | 90    "       |

showing a marked advantage in favour of the breech-loader, the gun detachment of which was not nearly so exposed as at the muzzle-loaders; the length of these latter guns was also found to be an inconvenience.

The competitive guns were afterwards thrown overboard from the boats, dragged ashore through the water, sand, and shingle, mounted, limbered up, and dragged a few yards, and then brought into action and a round fired from each.

The following are the periods recorded against each gun for the whole operation, after deducting what was due to the mounting of the carriages and limbers.

|                          |   |   | Mins. | Secs. |
|--------------------------|---|---|-------|-------|
| Breech-loading Armstrong | - | - | 3     | 30    |
| Whitworth                | - | - | 5     | 54    |
| Muzzle-loading Armstrong | - | - | 5     | 23    |

The difference in time is fairly due to the difference in the weight and handiness of the guns.

The Committee had found that the Armstrong muzzle-loading gun could be fired continuously without, or with only partial lubrication; and as they considered that contingencies might very possibly occur on active service which would prevent the employment of lubrication, the supply and transport of which must always cause an additional complication, and that therefore that gun would have a decided advantage for service in the field which should be capable of being fired with ease continuously without lubrication, it was determined to try the experiment of firing a number of rounds with only powder and shot. The Whitworth gun fired 86 rounds in 34½ minutes. The muzzle-loading Armstrong gun fired the same number of rounds in 28 minutes; both



made excellent practice; but the Committee did not complete the practice with the breech-loading Armstrong gun, as it became evident from the stripping of the lead from the projectile that this gun could not be used continuously without lubricators or water. The breech-loading apparatus also jammed, owing probably to the air space left by the abstraction of the lubricator.

Mr. Whitworth submitted with his stores a very ingenious instrument for extracting projectiles from muzzle-loading rifled guns; this instrument was frequently used during the experiments, and has now been introduced into the service.

The conclusion which the Committee have arrived at from all these trials and from the observations they have made during the whole course of their experiments, is that there is no practical difference in the ease of working between any of the guns, so long as lubrication is used, but that there is a very marked superiority in this respect in the muzzle-loading guns as compared with the breech-loading gun when no lubrication is used.

### RECOIL.

Measurements were taken of the recoil of the guns when fired under like circumstances on ordinary ground platforms, from which it resulted that the mean recoil of the breech-loading Armstrong 12-pounder was 66 in., of the Whitworth 12-pounder 58 in., and of the muzzle-loading Armstrong 12-pounder 76 in.

The Committee are of opinion that none of these guns have a recoil sufficiently violent to be of any practical disadvantage.

### RAPIDITY OF FIRING.

The experiments made for the purpose of testing the rapidity with which the several guns can be fired have been detailed in treating of their relative ease of working.

The results obtained from 483 rounds with the muzzle-loading guns, and 397 rounds with the breech-loading gun, fired at different times with average gun detachments, under circumstances as similar as possible, and conforming to the established drills of the service, are that the three guns can be fired as field guns at the following rates, which for all practical purposes may be considered as equal.

|                                            | Seconds. |
|--------------------------------------------|----------|
| The breech-loading Armstrong, one round in | 25·2     |
| Whitworth                                  | 24·7     |
| Muzzle-loading Armstrong                   | 25·3     |

When used as boat guns and fired from ordinary compressor carriages in moderately rough weather, an average of 10 rounds gave the following rates, in which the breech-loading gun has a decided advantage.

|                                        | Seconds. |
|----------------------------------------|----------|
| Breech-loading Armstrong, one round in | 59·5     |
| Whitworth                              | 90       |
| Muzzle-loading Armstrong,              | 90       |

In the experiment which was tried at Sir William Armstrong's request with a detail of duties different from that prescribed by the regulations, 100 rounds were fired from his breech-loading gun at the rate of one round in 8·18 seconds; this experiment was performed by a detachment of men selected from the experimental department at Shoeburyness, who were all highly trained and skilled gunners; little risk was therefore incurred in departing from the drill prescribed by the regulations; the Committee, however, did not feel themselves justified in incurring the risk of injury to the men of the gun detachment, which might have resulted from a trial for comparison, of the expedient, which might be resorted to on service, of firing a few rounds upon an advancing enemy at short range from the muzzle-loading guns without sponging.

The most rapid fire from Mr. Whitworth's gun was at the rate of one round in 17·6 seconds, and from Sir W. Armstrong's muzzle-loading gun one round in 16·5 seconds, both of which the Committee consider might probably have been reduced nearly to an equality with the breech-loader if for the purposes of the experiment the process of sponging had been omitted, and a careful selection made of their gun detachments.

The Committee, however, consider that practically when supplied with lubricators the capability of all the guns to sustain rapid firing is nearly on a par, and that all three can be fired with such rapidity as is consistent with steady aim and good practice, in which the ammunition will not be uselessly thrown away.

The Committee, however, as stated in treating of "ease of working," were not satisfied with these trials, but made a further experiment of firing 86 rounds from the competitive guns without lubricators.

The result was that the Whitworth gun was fired at the rate of one round in 24 seconds, and the muzzle-loading Armstrong gun at the rate of one round in 19·5 seconds, thereby showing that they may be fired with equal rapidity whether with or without lubrication, whereas the breech-loader was fired 20 rounds at the rate of one round in 33 seconds, but the experiment was not completed, as from the lead stripping from the shot, and the disarrangement of the breech-closing apparatus, it was evident to the Committee that the gun could not be used in this way.

As the difficulties of keeping up supplies of all necessary articles on service are very great, the Committee attach much importance to this experiment, which proves that the muzzle-loading guns have the great advantage of being capable of use without lubrication, without any loss in respect of rapidity of fire. From the impressions taken of the bores of these guns after this practice, it appeared that they were not injured by it.

## CAPABILITY OF STANDING THE ROUGH USAGE OF ACTUAL SERVICE.

### ENDURANCE.

In the course of the experiments which have been conducted by the Committee, three of the competitive guns have been fired the following number of rounds with their respective service charges, viz.,

|                                                                  | Rounds.   |
|------------------------------------------------------------------|-----------|
| The breech-loading Armstrong with $1\frac{1}{2}$ lbs. - - -      | - 2,800   |
| The Whitworth with $1\frac{3}{4}$ lbs. - - -                     | - „       |
| The muzzle-loading Armstrong, $1\frac{3}{4}$ lbs. - - -          | - „       |
| The breech-loading Armstrong gun, therefore, consumed 4,200 lbs. |           |
| The Whitworth gun - - - - -                                      | - 4,900 „ |
| The muzzle-loading Armstrong gun - - - - -                       | - 4,900 „ |

Showing a consumption of 700 lbs. of powder less by the breech-loader than by either of the muzzle-loaders.

The reports from the Inspector of Ordnance, which are to be found in the Appendix, show the condition of the guns at the various stages of the firing.

In the breech-loading Armstrong gun several slight fissures were visible in the powder chamber; the breech-piece was considerably scored in the slot by the escape of gas round the vent-piece; there was no expansion in the powder chamber; the shot chamber was expanded from ·002 to ·003 of an inch, and the bore for four inches in front of the shot chamber from ·029 to ·039 of an inch, whence the expansion decreased, but not uniformly, until it disappeared at 30 inches from the bottom of the bore.

In the Whitworth gun the bore was slightly scored by the escape of gas, extending 10 inches in front of the vent; slight fissures were visible extending 2·5 inches in length in front of the vent, and a slight opening round the cone of the vent, the deepest part being ·1 of an inch in the rear close to it; there was also a slight amount of expansion in the bore, from ·005 of an inch at the bottom of the bore to ·008 at six inches, and diminishing gradually to ·002 at 27 inches from it. There was also a slight amount of wear on the bearing side of the rifling, extending from 13 to 45 inches from the bottom of the bore; this wear was so slight that the Committee consider that these experiments have proved that guns of this calibre can be manufactured capable of sustaining the wear caused by the friction of hard metal projectiles passing along their bores in contact with them without the intervention of any softer metal.

In the muzzle-loading Armstrong or shunt gun, the bore and grooves were very much scored by the escape of gas, the scoring in the bore extending from 8 to 17 inches all round, and in the grooves from 7·5 to 19 inches from the bottom of the bore, the depth of the scoring in the grooves being about ·2 of an inch; slight fissures were visible in front of the vent ·3 of an inch in length, also a slight amount of wear round the edge of the vent copper extending nearly ·1 of an inch in depth; there was no expansion in the bore for the first five inches, after which there was a very slight expansion for four inches, amounting at its maximum to ·003 of an inch.

The loss in range at 5° elevation, as before stated, after firing these 2,800 rounds, was as under:—

|                          |   |            |
|--------------------------|---|------------|
| Breech-loading Armstrong | - | 267 yards. |
| Whitworth                | - | 119 „      |
| Muzzle-loading Armstrong | - | 305 „      |

These losses in range are in some measure due to the wear of the three guns.



The Committee, however, think it right to observe that the whole of the practice with Mr. Whitworth's gun was carried on with his lubricators, whereas from the muzzle-loading Armstrong gun 867 rounds at the commencement of the practice were fired without lubricators, when the effect of the scoring having been developed, the remainder of the practice was, at Sir W. Armstrong's request, carried on with his wads, by which the progress of the scoring in the bore was considerably reduced.

As these trials have been extended to a number of rounds far exceeding that which field guns in the ordinary course of service would be required to endure, they may be considered very satisfactory, as proving that steel or homogeneous metal can be used in the manufacture of field guns, and will stand the repeated shocks brought upon it by long and continued firing, and that practically all three guns are equal to the performance of the duties which may be required of them on service.

In order to test the effect on the bores produced by premature explosion of shells, the Committee caused five common and five segment or shrapnel shells to be burst in each gun as near as possible to the seat of the shot; to ensure this, holes were bored through the bases of the shells, and the ends of the cartridges opened, so as to bring the bursting charges in the shells in contact with the powder in the cartridges. The guns were examined after each round, when it was found that the breech-loading Armstrong gun had received some trivial indentations from the bursting of the first shell, but which were not increased by the subsequent rounds, and that the effects were not visible in the bores of the Whitworth and muzzle-loading Armstrong guns. The whole of the guns were afterwards fired at targets, when the result showed that their accuracy was not impaired.

In order further to try the relative power of the guns to endure the rough usage to which they may be subject on service, the Committee caused them to be thrown into a muddy ditch in the marsh, from which, after they had remained all night, they were taken out covered more or less with thick mud, and their bores more or less full of the same; they were then mounted, and ten rounds of solid shot were fired from each as rapidly as possible, the time being taken from the order to load.

The breech-loading Armstrong gun fired the first rounds in 2 min. 35 seconds, and completed the tenth round in 7 min. 15 seconds, but a delay of probably two minutes occurred from a mistake of one of the men of the gun detachment.

The Whitworth gun fired the first round in 1 min. 4 seconds, and completed the tenth round in 5 min. 10 seconds, having been subject to no check whatever.

The muzzle-loading Armstrong gun fired the first round in 3 minutes 30 seconds, and the tenth round in 7 minutes 50 seconds, but a very considerable delay was experienced in firing the first round, in consequence of the priming wire and pricker having been mislaid.

The Committee consider that the practical result of this experiment is to prove that neither gun possesses an advantage over the other in the rapidity with which it would be brought into action, if by any chance it were upset in a ditch.

The Committee have before alluded, under the head of ease of working, to an experiment tried in disembarking the guns from boats by throwing them overboard, and dragging them ashore through the water, sand, and shingle, in which the breech-loading Armstrong gun had a decided advantage, due to the difference in weight and the hole in the breech, which allowed the use of a handspike in mounting; the two muzzle-loading guns were about on a par.

The Committee further tested the endurance of the guns by having two rounds fired at each of them from a 9-pounder gun of the service pattern at a distance of 40 yards. For this purpose the guns were placed on skidding facing the gun which was to fire at them at an angle of about thirty degrees with its line of fire. Each of the guns was hit twice, and slightly indented. Subsequently four rounds were fired from each without difficulty.

The Committee are of opinion that these experiments are highly satisfactory, as showing the power of steel barrels to sustain any hits which they may receive on service; and considering the impossibility of ensuring identity in the direction and force of the blows, they are further of opinion that the experiment proves that practically there is little difference between the several guns in this respect.

The Committee have further to report that the breech screw of the breech-loading Armstrong gun exhibited no signs of injury after 2,800 rounds, and that no case occurred of a vent piece blowing out or cracking.

The only damage which the breech-loading arrangement sustained was from the wear of the copper bouche ring in the bore and the copper rings on the three vent pieces, all

of which required re-facing six times, or once on the average of 466 rounds, and renewal twice, the first time after 867 rounds, and the second time after 904 rounds. The three vent pieces also were re-bouched once after 2,362 rounds.

The Whitworth gun was re-vented eight times during the 2,800 rounds, three of which occurred in firing the first 376 rounds, the next vent stood 1,187 rounds, and two others 188 and 319 rounds respectively.

The failure of the first vents was due to an attempt to line the vent with platinum, which entirely failed, after which an ordinary copper vent plug was inserted, the endurance of which was satisfactory.

The muzzle-loading Armstrong gun has only been vented twice, the first time after 1,714 rounds and the second after 524 rounds; the endurance of these vents has also been satisfactory.

After all the practice with these 12-pr. guns had been completed, the Committee decided to burst the guns by firing a series of rounds with the service charge of powder, and one or more shot with air spaces between the charges and shot, the object being to ascertain which gun would have the greatest powers of endurance, and also the manner in which they would burst; whether they would give indications of weakness, or burst by a sudden and totally unexpected explosion.

The following Table shows the number of rounds fired:—

| Series. | Rounds fired. | Space between Cartridge and Shot. | Number of Shot each Round. | Number of Cartridge. | Cartridge. |                 | Projectile.     |                  |                                                                   |
|---------|---------------|-----------------------------------|----------------------------|----------------------|------------|-----------------|-----------------|------------------|-------------------------------------------------------------------|
|         |               |                                   |                            |                      | Length.    | Weight.         | Length.         | Weight.          |                                                                   |
|         |               | Inches.                           |                            |                      | Inches.    | lbs.            | Inches.         | lbs.             |                                                                   |
| 1       | 11            | 6                                 | 1                          | 1                    | 6          | 1 $\frac{1}{2}$ | 7               | 11 $\frac{1}{8}$ | B. L. } Sir W. Armstrong.<br>Shunt }<br>Hexagonal, Mr. Whitworth. |
| 2       | 5             | 6                                 | 1                          | 1                    | 7          | 1 $\frac{3}{4}$ | 7 $\frac{1}{2}$ | 11 $\frac{1}{2}$ |                                                                   |
| 3       | 5             | 12                                | 3                          | 1                    | 9          | 1 $\frac{3}{4}$ | 8 $\frac{1}{2}$ | 12               |                                                                   |
| 4       | 5             | 12                                | 6                          | 1                    |            |                 |                 |                  |                                                                   |
| 5       | 10            | 12                                | 5                          | 2                    |            |                 |                 |                  |                                                                   |
| 6       | 2             | 12                                | 1                          | 1                    | —          | —               | —               | —                |                                                                   |
| 7       | 6             | 6                                 | 6                          | 2                    |            |                 |                 |                  |                                                                   |
| 8       | 48            | 6                                 | 6                          | 2                    |            |                 |                 |                  |                                                                   |

The trunnion ring of the breech-loading Armstrong gun was cracked in the 33rd round of the experiment, and at the 42nd round it was fractured, and opened to the extent of an inch; the steel barrel underneath was also cracked, rendering the discontinuance of the experiment necessary. No injury was reported to the breech-loading apparatus or vent piece, which thus outlived the gun.

At the 92nd round the Whitworth gun burst violently into 11 pieces; the fore part of the gun was thrown forward on the butt, the breech was blown to the rear, and other parts dispersed through the cell, one part lodging in the timber work. The fracture of the gun passed through the vent in a direct line towards the muzzle, and not in the direction of the rifling.

The steel barrel of the muzzle-loading Armstrong shunt gun was cracked in the 60th round of the experiment; the coil in front of the trunnion was found open and lying near to the gun, as if it had simply fallen off.

In the course of these experiments, measurements were taken of the expansions of the bores; these are given in the Appendix; but there were no indications during the course of these experiments of change of form by any test which could be applied in the field.

It would appear, therefore, that, although Mr. Whitworth's gun possessed greater endurance, it possessed the disadvantage, as compared with Sir W. Armstrong's guns, of not giving indications such as could have been observed on service of the approaching destruction of the gun.

The Committee, however, desire to observe that these experiments exhibit a degree of strength in all the guns which far surpasses the possible requirements of the service.

#### *Capability of bearing continued firing with the Maximum Charge adapted to the Gun.*

The Committee have already detailed, under the head of "rapidity of firing," the experiments made with a view to testing the powers of the various guns to sustain continued and rapid firing; they have only to observe that although the guns became exceedingly hot, so much so that they could scarcely be served, they were in no way injured when fired with lubricators beyond an amount of wear in the bores such as might have been reasonably expected.



The two muzzle-loading guns were equally uninjured when fired without lubricators, but the experiment was not completed with the breech-loading Armstrong gun for the reasons before stated.

### SIMPLICITY OF CONSTRUCTION.

The breech-loading 12-pounder gun is composed of a steel barrel with one layer of wrought-iron coils in three portions, and a trunnion ring shrunk on over it.

The steel barrel extends throughout from the rear end of the breech piece to the muzzle, the coils being superimposed only over the breech, and to a distance of 5·75 inches in front of the trunnions.

These field guns, therefore, may properly be described as steel guns strengthened by superimposed coils of wrought iron.

The steel in the guns is in the first instance procured from the manufacturers of steel in the form of solid ingots, which have been cast and hammered; these ingots are then drawn down at the gun factory under the hammer, and tested by samples taken from each end, after which, if passed, they are bored and turned, and then re-examined with care and tempered in oil.

The wrought-iron coils having been welded up and very carefully turned, so that their internal diameters are somewhat smaller than the barrels, are heated and shrunk on at one time over the barrels, which are kept cool during the process by a continuous flow of water through them.

The gun is then completed by turning the exterior and forming the screw in the breech piece, by screwing a copper ring into the breech end of the bore, and by fixing an eye for the elevating screw.

The breech-closing apparatus has then to be supplied, consisting for each gun of three vent pieces, with copper rings on them, and copper bouches in their vents, of one breech screw, one tappet, and one tappet ring. These vent pieces are supplied in triplicate for exchange.

The bore consists of the "powder chamber," the "bullet chamber," and the "barrel." The powder chamber is 8·75 inches in length, is not rifled, but is bored out to the depth of the rifling in the bore, a shoulder being left between it and the lands of the bullet chamber, against which the enlarged base of the shot jams when rammed home. The bullet chamber extends 3 inches in length in front of the powder chamber; in it, the diameter of the rifling is the same as of that in the rest of the bore, but the lands are of a less height than in the barrel, the rifling of which is of uniform pitch throughout, and consists of 38 grooves ·05 of an inch in depth, and ·15 of an inch in breadth.

Each battery, in addition to spare articles connected with the breech-loading apparatus, is supplied with a box of facing implements weighing 105 lbs. and containing 25 articles required for re-facing the vent pieces and bouche rings, and with a set of special tools in two boxes, together weighing 83 lbs., containing a large number of articles. The value of the tools in these three boxes is 32*l*.

The care and conveyance of these tools is of serious consequence, and as they can only be used by skilled men they add materially to the complications of the artillery service.

The loss of the tools, or the absence of men skilled in the use of them, might seriously impair the efficiency of a battery in a campaign.

Mr. Whitworth's 12-pounder gun is made of solid homogeneous metal or mild steel, with a hoop of the same material over the powder chamber; the metal is supplied to him by the manufacturers of steel, by whom it is cast and hammered and the ingot cut off to the required length. A piece is then turned off from the breech end, to which the necessary tests are applied to determine the process for hardening and tempering.

The ingot is now turned in a lathe from one end to the other, and rough bored cylindrically; it is then heated to the temperature which has been proved by the test pieces sufficient, and hardened and tempered by immersion in oil.

After being so tempered it is again turned and the boring and rifling are finished to what may be described in general terms as an hexagonal bore. It is not, however, strictly hexagonal in form, but has 24 surfaces; part of the original cylindrical bore is left in the centre of each side of the hexagon, making six surfaces, then there are the coming-out sides of the hexagon, which give six more surfaces, and the going-in sides, giving also six surfaces, and lastly the rounding-off of the angles, which give six more. The section of the bore is the same, and the twist uniform throughout; there is no special formation either for powder or bullet chambers.

The trunnions, which are made in a solid block of wrought iron or steel, are bored out and then screwed on to the gun.

3284.  
3226.

3229.  
3250.  
3256.  
3294.  
3374.  
3544.

3551.  
3570  
3557.

App. p. 162.  
App. p. 162.

3726.  
3728.  
3763.  
3778.  
3787.  
3774.

3785.  
3786.  
3796.  
3731, 3766.  
3767.  
3768.  
3795.

3856.  
3858 to 3861.

3934. A breech screw is then screwed into the piece, the bottom of the bore being formed by a small copper cup resting against the end of this screw.

3750-1. Mr. Whitworth, in the first instance, inserted a vent bouched with copper in the axis of the piece, with the intention of firing the gun through the breech screw, but afterwards substituted another vent in the usual position, in consequence of a representation by the Commandant at Shoeburyness that the use of this vent in its then condition involved some risk to the man in firing. By so doing he considered the metal in the gun was weakened, and he therefore added the hoop, above referred to (15 inches long and .75 inches in thickness), which was forced on by hydraulic pressure, to make up for the diminished strength of the breech consequent on the alteration of the vent.

3711. Mr. Whitworth stated that, if he had intended originally to make his vent on the upper part of the gun, instead of in the prolongation of the axis, he should have made up for the loss in strength, consequent on piercing the metal of the gun, by an additional thickness in the solid block of which the gun was made, which would have rendered unnecessary the addition of the hoop.

3752. The muzzle-loading Armstrong or shunt gun is made, similarly to the breech-loading gun, of steel, with coils and trunnion ring superimposed, the breech end of the bore being closed by a screw. The vent is on the upper side, at a distance of 3.5 inches from the bottom of the bore. The rifling is equal throughout, and is formed of three grooves, each of which is made wider than the studs upon the shot; they are so contrived that the studs, in going down the bore, press against one side of the grooves, which are narrowed towards the breech end, so as to throw the studs over, or "shunt them," against the other side when the shot is rammed home, so that when fired it passes out of the bore with the studs pressing against the opposite side of the grooves. When the projectile, in its passage along the bore, arrives at 16.25 inches from the muzzle, the studs meet inclined planes occupying nearly one-half of the width of the grooves; these inclined planes, by lessening the depth of the grooves very gradually towards the muzzle, cause the studs to be compressed, and they are thus intended to deliver the shot steady at the moment of its leaving the muzzle.

It will thus appear that in this gun there is a certain point in the bore beyond which the shot cannot be driven; this is bored cylindrical, and constitutes the powder chamber.

Having thus described the construction of the several guns, the Committee have to report that, considering the number of spare articles which must be carried with each breech-loading gun to ensure its efficiency, and the number, weight, and cost of special tools and implements, and the complication in the store department consequent on their issue and maintenance with field batteries under all conditions of service, and considering also the necessity there is that men skilled in the use of these implements should always be present with each battery to use them and keep the guns in efficient repair, they are of opinion that this gun is far inferior as regards simplicity of construction to either of the muzzle-loading guns, and cannot be compared to them in this important respect in efficiency for active service.

With respect to the two muzzle-loading guns, they have to report that there is no very material difference as regards simplicity of construction with guns not exceeding in calibre the 12-pounders; the Whitworth gun, however, is manufactured of one material (except the trunnion ring), has a like section of bore throughout; whereas the Armstrong muzzle-loader is made of two materials, has a special powder chamber, and besides the shunt arrangement the grooves have inclines towards the muzzle, which makes the section of the bore vary.

#### COMPARATIVE COST, SO FAR AS CAN BE ASCERTAINED BEFORE THE MANUFACTURE HAS BEEN SYSTEMATICALLY ESTABLISHED.

The Committee have given much consideration to this subject, but find it exceedingly difficult to arrive at any precise conclusion thereon.

The cost of the 12-pounder guns supplied to the Committee for experiment has been as follows:—

|                                          |       |
|------------------------------------------|-------|
| 3 Breech-loading Armstrong guns at 254/. | each. |
| 3 Whitworth                              | 122/. |
| 3 Muzzle-loading Armstrong               | 226/. |

Both Sir William Armstrong and Mr. Whitworth object to these prices being taken as fair criteria from which to judge of what the cost of their respective guns would be if the manufacture were fully established to meet a large demand; in this opinion the Committee quite concur.



From the description given under the head of simplicity of construction, it will be evident that the two muzzle-loading guns are much about on a par with each other in respect of the processes they have to undergo in their manufacture; if anything, there is rather less work on the Whitworth, which probably is compensated by its being a hundredweight heavier, and having more steel in it, so that these two guns, if made in the same factory, and under like conditions, would be supplied at costs which, for all practical purposes, may be considered equal.

The breech-loading Armstrong gun is half a hundredweight lighter than the muzzle-loading Armstrong gun, and 1·5 cwt. lighter than the Whitworth gun, but the Committee consider that this saving in metal is more than compensated in cost by the additional work necessary in the manufacture of the various parts of the breech-loading apparatus, with its spare vent pieces, &c., and the tools and implements for their repair, and that if the cost of all these be considered, the breech-loading gun must be rather the more costly of the three guns.

The Committee, however, are of opinion that the difference in cost of these guns will be so small, compared to the gross sum required for the supply of the whole of the guns which would be necessary to meet all the demands of Her Majesty's service, that it bears no proportion to the interests at stake in the selection of the most efficient weapon, and they therefore consider that the mere cost of the guns should in no way influence the decision as to the field gun which should be adopted for the service.

### PROJECTILES, FUZES, AND AMMUNITION.

The Committee having thus reported on the field guns proceed to consider the projectiles, fuzes, and ammunition which have been brought before them.

The projectiles for Sir W. Armstrong's breech-loading gun are made of cast iron, coated with lead. Throughout all the practice conducted by the Committee projectiles have been used in which the lead was attached by the zinc process, as it is termed, which is applied as follows:—

Each projectile, after being cast, is placed in a lathe, when the part to receive the lead is turned; it is then heated in an oven previous to being dipped in a solution of sal ammoniac to remove all traces of oxide, preparatory to being placed in a zinc bath. After remaining in this bath for a short time it is placed in a mould, and the lead poured round it. The projectile is then again put in a lathe, and turned to its exact dimensions.

The zinc process has, as stated in an early part of this report, been universally adopted in Her Majesty's service for the field artillery on the Armstrong system, after considerable experience with the lead attached by other means. Sir W. Armstrong, being of opinion that the projectiles for his breech-loading gun were too high gauge for the steel barrel, which was found to expand less than the coil barrels ordinarily used, requested that a number of rounds might be fired with projectiles of a reduced gauge, in some of which the lead was attached by the zinc process, and in others by the undercut process, which he considered might take the grooving better than the zinced projectiles.

In attaching the lead by the undercut system, a series of undercut rings are turned on that part of the projectile which is to be coated with lead; the projectile is then heated and placed in a mould, and the lead poured round it, after which it is turned to its exact dimensions in a lathe.

The following table shows the results of the practice with these special projectiles, the results previously reported as having been obtained from the practice with the other projectiles being tabulated with them for comparison.

| Nature of Projectile.  | Elevation. | Special Projectiles. |             |                  | Projectiles used in Committee's Experiments. |                 |                  |             |                  |                 |                  |
|------------------------|------------|----------------------|-------------|------------------|----------------------------------------------|-----------------|------------------|-------------|------------------|-----------------|------------------|
|                        |            | Armstrong B. L.      |             |                  | No. of Rounds.                               | Armstrong B. L. |                  | Whitworth.  |                  | Armstrong M. L. |                  |
|                        |            | No. of Rounds.       | Mean Range. | Radial Distance. |                                              | Mean Range.     | Radial Distance. | Mean Range. | Radial Distance. | Mean Range.     | Radial Distance. |
| * Solid shot - -       | 2          | 17                   | 1,168       | 47               | 18                                           | 1,186           | 54               | 1,283       | 33               | 1,265           | 39               |
| " - -                  | 5          | 17                   | 1,991       | 197              | 18                                           | 2,115           | 131              | 2,330       | 101              | 2,230           | 114              |
| * Segment shell - -    | 2          | 18                   | 1,336       | 57               |                                              |                 | Not fired.       |             |                  |                 |                  |
| " - -                  | 5          | 18                   | 1,952       | 136              | 17                                           | 2,080           | 147              | 2,264       | 138              | 2,277           | 165              |
| Zinced shot - -        | 2          | 36                   | 1,184       | 44               | 18                                           | 1,186           | 54               | 1,283       | 33               | 1,265           | 39               |
| " - -                  | 5          | 18                   | 2,215       | 104              | 18                                           | 2,115           | 131              | 2,330       | 101              | 2,230           | 114              |
| Zinced segment shell - | 2          | 18                   | 1,165       | 52               |                                              |                 | Not fired.       |             |                  |                 |                  |
| " - -                  | 5          | 18                   | 1,921       | 63               | 17                                           | 2,080           | 147              | 2,264       | 138              | 2,277           | 165              |

\* Undercut.

From the above table it appears that the undercut projectiles specially prepared by Sir W. Armstrong give practically the same results as the projectiles used in the competitive experiments made by the Committee. The special zincd projectiles, with reduced gauge, appeared, in respect of accuracy, far superior to the projectiles used from the breech-loading gun in the competitive experiments, and, with segment shell, gave better results than those obtained with either the Whitworth or muzzle-loading shunt gun. The Committee, however, observe that this last result has been obtained from an exceedingly limited number (only 18) of rounds fired at 5° elevation.

The Committee have devoted considerable time and attention to testing the comparative values, for service in the field, of the various projectiles which have been brought before them.

They commenced these trials by firing against field works, abattis, rope mantlets, walls, stockades, lines and columns of targets.

The records of the whole of this practice are to be found in the Appendix.

In the experiments against field works, the practice was carried on at various ranges from 600 to 1,300 yards against an ordinary earthen parapet with embrasures, each armed with a gun mounted on a garrison carriage, around which were placed wood figures to represent the gun detachments; a target 18 feet long by 9 feet broad was also placed in rear of each gun. In front of the earthwork was an abattis.

The result of this practice showed that either of the guns may be used with effect at these ranges.

The results of 45 rounds per gun of this practice were as follows:—

*Armstrong B. L. Gun.*—Both cap squares of the gun fired at broken, carriage damaged, 13 figures struck, 136 holes in target, 26 fragments lodged.

*Whitworth.*—Hit the gun fired at twice, eight figures struck, 87 holes in target.

*Armstrong M. L.*—Four figures struck, 35 holes in target, 14 fragments lodged.

The abattis was rendered practicable for assault by 15 rounds at 600 yards from the breech and muzzle loading Armstrong guns, but very little damaged by the Whitworth gun. The effects on these abattis, however, as well as on the earthworks, were dependent so much on a variety of circumstances, and on chance, that the Committee found it impossible to form an accurate opinion from them, either as to the relative merits of the guns or of the projectiles.

Subsequently ordinary rope mantlets, composed of four plies of 4-inch rope, were suspended against the embrasures, behind each of which, at a distance of six yards, was placed a target 18 feet long by 9 feet high.

Three rounds of segment or shrapnel shell were fired from each gun at 400 yards, to burst in front of the mantlets, through wood screens, to represent the action of time fuzes. The results were as follows:—

Armstrong breech-loader, 1 hole through the mantlet, no hits on the target.

Whitworth, 14 holes through the mantlet, 37 hits on the target.

Armstrong muzzle-loader, 1 hole through the mantlet, 4 hits on the target.

Two rounds were then fired from each, to burst by the action of the fuzes, when, passing through the mantlets, the results were as follows:—

Armstrong breech-loader, 170 hits on target.

Whitworth, 216 ditto.

Armstrong muzzle-loader, 200 ditto.

A marked superiority was here apparent in the penetrating powers of the bullets of the shrapnel shells; it was also evident that rope mantlets, of the construction used in the experiments, afford no efficient protection against either segment or shrapnel shells fired with percussion fuzes to burst on passing through them, nor against the bullets of the shrapnel shells when burst at short distances in front of them.

The Committee considered that their inquiry would have been incomplete without testing the capabilities of the guns and ammunition for breaching defences frequently made use of in field operations, such as churches, large country houses, &c.: for this purpose three walls 28 inches thick, built with the best bricks laid in cement, were fired at with shot, common, segment, and shrapnel shells at a range of 1,150 yards.

The walls, after 15 rounds from each gun, were all considerably damaged, and the targets behind bore unmistakeable evidence that at this range such walls would afford very little defence against field guns of either description. At the conclusion of the practice there appeared to be very little difference in the amount of damage done by the guns. That fired at by B. L. Armstrong, most damaged; M. L. Armstrong, next



damaged; Whitworth, next damaged. As regards the targets in rear, the relative damage done by the splinters was as follows; M. L. Armstrong, most damage, most distributed; B. L. Armstrong, next, most concentrated; Whitworth, least damage, considerably less so than either of the other two.

The damage done, however, was of that nature that the Committee could form no very exact opinion as to which gun had produced the greatest effect.

Similar experiments were tried against stockades formed of elm logs, 14 inches thick, firmly fixed in the ground; practice against these stockades at 800 yards proved that, though from the nature of the material they could not easily be breached by guns of such small calibre, they afford very inadequate protection against the effect of shells burst by the action of percussion fuzes in passing through them.

The effects, however, were not such as to admit of a comparison between the several guns.

The Committee also caused nine rounds of segment shell to be fired from each gun at some unserviceable field guns, with dummy figures placed around them, to represent the gun detachments.

The following are the results :—

|  | Gun.                     | No. of Figures struck. | Hits on Carriage and Limber. |
|--|--------------------------|------------------------|------------------------------|
|  | Breech-loading Armstrong | 29                     | 16                           |
|  | Whitworth                | 19                     | 23                           |
|  | Muzzle-loading Armstrong | 31                     | 53                           |

Besides the above results there was considerable damage done to the limber and carriage by the M. L. Armstrong gun, whereas no similar injury was done by either of the two other guns.

Thus according to this practice the M. L. Armstrong would exhibit a superiority to the other two guns. The Committee, however, observe that these results depend in great measure upon the chance of the projectiles striking in favourable positions.

The Committee also tried some experiments with segment and shrapnel shell, used as a substitute for common case.

The ranges at which this practice was conducted varied from 50 to 450 yards.

In the practice at 450 yards five rounds were fired from each gun at six lines of targets 2 inches thick, 54 feet long by 9 feet high, placed so as to represent troops in column at quarter distance; the mean number of hits per round was as follows :—

|                          | 1st Line. | 2nd Line. | 3rd Line. | 4th Line. | 5th Line. | 6th Line. | Total. |
|--------------------------|-----------|-----------|-----------|-----------|-----------|-----------|--------|
| Breech-loading Armstrong | 1         | 12        | 53        | 58        | 16        | 1         | 141    |
| Whitworth                | 16        | 25        | 33        | 30        | 18        | 9         | 131    |
| Muzzle-loading Armstrong | 1         | 29        | 79        | 77        | 52        | 16        | 254    |

Subsequently the same number of rounds were fired at the same targets, and the record taken of the number of men that would have been struck if the targets had been replaced by men.

The total number of hits was as follows :—

|                          | 1st Line. | 2nd Line. | 3rd Line. | 4th Line. | 5th Line. | 6th Line. | Total. |
|--------------------------|-----------|-----------|-----------|-----------|-----------|-----------|--------|
| Breech-loading Armstrong | 3         | 7         | 25        | 32        | 24        | 17        | 118    |
| Whitworth                | 12        | 11        | 17        | 15        | 16        | 18        | 89     |
| Muzzle-loading Armstrong | 5         | 7         | 27        | 31        | 30        | 18        | 108    |

It would appear from this result that the segment shell has in both instances some superiority over the shrapnel so far as the total effect on the column is concerned, but as at this range troops may be expected to advance either in line or in skirmishing

order, the shrapnel, as having most effect on the first line, would probably prove the most destructive.

The Committee have to report that the effects produced at short ranges were not very great, and as the time necessary to adjust the fuzes would render segment and shrapnel shells of comparatively little value in checking a rapid advance, or for any purpose for which common case is intended to be used, the Committee consider it absolutely necessary that field artillery should be invariably supplied with common case shot.

The Committee subsequently therefore carried on a series of experiments with common case shot proposed by Lieutenant Reeves, R.A., for use from Sir W. Armstrong's guns and by Mr. Whitworth for his own guns, at single lines of deal targets 2 inches thick, 54 feet long by 9 feet high, at ranges varying from 50 to 350 yards.

In the comparison of the effects, which are deduced from five rounds at each range, the Committee have only taken account of such shot or fragments as either went through the targets or lodged in them.

The following tables give the mean number of such hits per round at each range.

| Reeves' Case Shot<br>Mr. Whitworth | Weights.<br>{ B. L. 12 lbs. 4 oz.<br>M. L. 11 lbs. 14 oz.<br>- 14 lbs. 13 oz. | Mean Number of Hits at |          |          |          |         |
|------------------------------------|-------------------------------------------------------------------------------|------------------------|----------|----------|----------|---------|
|                                    |                                                                               | 350 yds.               | 250 yds. | 200 yds. | 150 yds. | 50 yds. |
| Breech-loading Armstrong           | -                                                                             | 6                      | 12       | 19       | 28       | 61      |
| Whitworth                          | -                                                                             | 15                     | 25       | 34       | 33       | 104     |
| Muzzle-loading Armstrong           | -                                                                             | 6                      | 7        | 11       | 18       | 55      |

The superiority of Mr. Whitworth's case shot was very marked throughout this practice; and the Committee are of opinion that it is an invention of very great value to Her Majesty's service.

As the Committee attach very great importance to the effects produced by segment and shrapnel shells when fired from field guns, they went through a long and tedious course of experiments to test these projectiles.

The segment shell tried with Sir William Armstrong's guns were of the pattern in ordinary use in Her Majesty's service, adapted either by lead coating when fired from the breech-loading gun, or by having soft metal studs inserted in them for the muzzle-loading or shunt gun.

The shrapnel shells fired from Mr. Whitworth's gun have been designed by Colonel Boxer, R.A., and made up in the Royal Arsenal, the peculiarity of their construction being that they are filled with bullets and are intended to be fired with two different bursting charges (6 or 12 drams), according to circumstances; the smaller bursting charge is calculated to blow off the head of the shell and to liberate the bullets, leaving the body of the shell to continue its flight and take effect as a shot; the larger burster is calculated to break up the shell, when its fragments as well as the bullets proceed on their course with but slight loss of velocity.

The object in these experiments having been to record the effects of the shells, burst otherwise than by graze and under like conditions, without any complications or questions as regards the action of the fuzes, the Committee decided to fire a number of rounds at several ranges, bursting the shells as nearly as possible in exactly similar positions, so as to obtain fair results, from which all elements of chance should, as far as possible, be eliminated, and by which to judge of their relative merits.

For this purpose it was ascertained by preliminary experiments that the action of the percussion fuzes took effect after passing through wood screens,—

With the breech-loading Armstrong gun at 7 yards.

With the Whitworth „ at 10 do.

With the muzzle-loading Armstrong „ at 8 do.

Screens therefore were erected in front of the rows of targets, upon which the effects of the shells were to be recorded, so that the shells should burst at 10, 25, 50, or 100 yards from the targets, and by selecting for comparison those shells which had hit the screens in similar positions at nearly equal heights from the ground, the Committee have been enabled to compare the results produced upon the targets by shells burst under conditions as nearly as possible similar to each other.

In this practice, single lines of targets two inches thick, as well as three lines of targets one behind the other to represent columns of troops, were used, and in the following



tables are exhibited the results, the number of hits given being the mean number of bullets or fragments per round which either went through, or lodged in, the targets.

## PRACTICE AT ONE LINE OF TARGETS.

| Shell burst<br>in front of<br>Targets at<br>a Distance of | Range. | Length of<br>Target, 9 feet<br>high. | No. of<br>Rounds. | Mean Hits per Round. |            |                  |
|-----------------------------------------------------------|--------|--------------------------------------|-------------------|----------------------|------------|------------------|
|                                                           |        |                                      |                   | B. L. Armstrong.     | Whitworth. | M. L. Armstrong. |
| yards.                                                    | yards. | feet.                                |                   |                      |            |                  |
| 25                                                        | 600    | 27                                   | 10                | 40                   | 40*        | 48               |
| 50                                                        | —      | 54                                   | 4                 | 15                   | 26*        | 26               |
| 50                                                        | —      | 27                                   | 6                 | 10                   | 23*        | 13               |
| 100                                                       | —      | 72                                   | 10                | 8                    | 14†        | 11               |
| 10                                                        | 800    | 72                                   | 10                | 64                   | 64*        | 64               |
| 25                                                        | —      | 72                                   | 10                | 47                   | 58*        | 50               |
| 50                                                        | —      | 72                                   | 10                | 30                   | 42*        | 32               |
| 100                                                       | —      | 72                                   | 10                | 15                   | 26†        | 12               |

\* 12 dram bursters used.

† 6 dram bursters used.

## PRACTICE AT THREE LINES OF TARGETS.

| Shell burst<br>in front of<br>leading<br>Target at a<br>Distance of | Range. | Length of<br>Target, 9 feet<br>high. | No. of<br>Rounds. | Mean Hits per Round. |           |           |        |            |           |           |        |                  |           |           |        |
|---------------------------------------------------------------------|--------|--------------------------------------|-------------------|----------------------|-----------|-----------|--------|------------|-----------|-----------|--------|------------------|-----------|-----------|--------|
|                                                                     |        |                                      |                   | B. L. Armstrong.     |           |           |        | Whitworth. |           |           |        | M. L. Armstrong. |           |           |        |
|                                                                     |        |                                      |                   | 1st line.            | 2nd line. | 3rd line. | Total. | 1st line.  | 2nd line. | 3rd line. | Total. | 1st line.        | 2nd line. | 3rd line. | Total. |
| yards.                                                              | yards. | feet.                                |                   |                      |           |           |        |            |           |           |        |                  |           |           |        |
| 10                                                                  | 1,300  | 45                                   | 6                 | 63                   | 34        | 7         | 104    | 55         | 47        | 29        | 131    | 62               | 24        | 3         | 89     |
| 100                                                                 | "      | "                                    | 9                 | 4                    | 1         | 0         | 5      | 10         | 7         | 4         | 21     | 7                | 2         | 1         | 10     |
| 10                                                                  | "      | "                                    | 6*                | —                    | —         | —         | —      | 57         | 51        | 30        | 138    | —                | —         | —         | —      |
| 10                                                                  | "      | "                                    | 6†                | —                    | —         | —         | —      | 48         | 43        | 30        | 121    | —                | —         | —         | —      |
| 100                                                                 | "      | "                                    | 8*                | —                    | —         | —         | —      | 10         | 5         | 3         | 18     | —                | —         | —         | —      |
| 100                                                                 | "      | "                                    | 8†                | —                    | —         | —         | —      | 10         | 9         | 4         | 23     | —                | —         | —         | —      |

\* 12 dram bursters used.

† 6 dram bursters used.

In the practice, the results of which are recorded in the above tables, bursters weighing 6 and 12 drams were used in the shells fired from the Whitworth gun for comparison with those fired from the two Armstrong guns, but in order to test the relative value of the two bursters proposed by Colonel Boxer, the Committee caused a number of rounds to be fired with those bursters, the results of which are recorded in the latter part of the second table above.

After a careful consideration of this practice the Committee have to report that when the shells are burst at only 10 yards in front of the targets, the concentration of the fragments with all the guns is greater than is desirable when fired against troops in line, almost the whole effect having been produced in each case upon a front of 18 feet. Where the shells were burst at 25 yards, the distribution was better, and the effect of the three guns was about equal when fired against troops in line; but when burst at 50 and 100 yards in front of troops in line, Colonel Boxer's shrapnel shell has a marked superiority, due to the bullets maintaining their velocity and direction better than the segments of Sir W. Armstrong's shell.

When fired with the time fuze at columns of troops the greater penetration of the bullets of Colonel Boxer's shrapnel shell make it a much more formidable projectile than Sir W. Armstrong's segment shell; and the Committee further observe that there appears to be no necessity for complicating the shrapnel shell with two bursting charges.

The Committee afterwards fired a number of rounds at 1,300 yards at three lines of targets, 45 feet in length, so that the shells should burst by the action of the percussion fuzes on grazing on the sands. Only three rounds, in which the grazes were from 27 to 75 yards in front of the targets, gave results which could be compared.

## MEAN NUMBER OF HITS ON TARGET.

|          |     | B. L. Armstrong. | Whitworth. | M. L. Armstrong. |
|----------|-----|------------------|------------|------------------|
| 1st Line | - - | 18               | 2          | 23               |
| 2nd Line | - - | 8                | 2          | 8                |
| 3rd Line | - - | 1                | 0          | 0                |
| Total    | -   | 27               | 4          | 31               |

Several rounds were also fired to burst in the same manner in front of a single line of targets with a frontage of 63 feet at a distance of 800 yards from the guns. But the practice was discontinued as there were nine blind shells in succession from the Whitworth gun.

The mean number of hits of the rounds which served for comparison was,—

|                              |   |   |   |    |
|------------------------------|---|---|---|----|
| Breech-loading Armstrong gun | - | - | - | 49 |
| Whitworth gun                | - | - | - | 30 |
| Muzzle-loading Armstrong gun | - | - | - | 55 |

The Committee have to observe that this practice took place on the level ground at Shoeburyness, which presents more favourable conditions for such practice than would generally be met with on service. It appears from it, that Colonel Boxer's shrapnel shell, as fired from Mr. Whitworth's gun, is far inferior to Sir W. Armstrong's segment shell when burst by grazing on the ground, both as to the number of fragments which hit and their distribution; but the Committee observe that, even under the most favourable conditions, when burst by grazing more than 50 or 60 yards in front of troops, their effect is comparatively small, thus showing the importance to be attached to a good time fuze, and that it should invariably be used with these shells in the field, in combination with the percussion fuze. As it appeared also that in the practice recorded above for range and accuracy, 18 out of the 112 shrapnel shells broke up in the bore of the Whitworth gun, and that in firing at targets at 2,600 yards, 11 out of 20 broke up on graze, the Committee consider that these projectiles, as submitted to them, are not sufficiently strong.

Upon reviewing the whole of the practice with Sir William Armstrong's segment and Colonel Boxer's shrapnel shells, and taking into due consideration the fact that the principle of the shrapnel shell is not confined to the form of shell used in the Committee's experiments, but may be applied to any form of projectile, also that the description of fuze best adapted for ricochet practice may be used with it, the Committee are of opinion that the shrapnel shell is the more formidable projectile of the two.

At the request of Mr. Whitworth the Committee also fired 17 rounds from his gun at 5° elevation with a common shell (not tooled), three diameters long, filled with sand.

The results were as follows:—

|                          |           |              |
|--------------------------|-----------|--------------|
| Range                    | - - - - - | 2,101 yards. |
| Mean error in range      | - - - - - | 20.5 "       |
| Mean error in deflection | - - - - - | 1.8 "        |
| Radial distance          | - - - - - | 103 inches.  |

There is no series of common shell practice with which these results can be compared; the shooting was, however, very good, being nearly equal to the Whitworth solid shot at 5°.

Ten rounds also were fired at 45° elevation with charges of 3½ oz., and shells 5 diameters long.

|                          |           |              |
|--------------------------|-----------|--------------|
| Range                    | - - - - - | 1,225 yards. |
| Mean error in range      | - - - - - | 50.6 "       |
| Mean error in deflection | - - - - - | 3.3 "        |

Five rounds were also fired at 33° of elevation with common shell, which Mr. Whitworth considered of the best form for flight, with charges of 2, 1¾, and 1½ lbs. of powder; the ranges obtained were with—

|                |           |              |
|----------------|-----------|--------------|
| 2 lbs. charges | - - - - - | 7,579 yards. |
| 1¾ "           | - - - - - | 7,535 "      |
| 1½ "           | - - - - - | 7,594 "      |

The range obtained with the ordinary solid shot at 33° of elevation with the proposed service charge of 1¾ lbs. was 8,776 yards.



Having thus tried the effects of the various kinds of ammunition when fired, the Committee caused some packed limber boxes to be travelled a distance of 200 miles over moderately rough roads. Although the lead on the projectiles for the breech-loading gun was generally scored, and in some cases much cut and scored, they were none of them injured so as to be unfit for use.

The buttons of the whole of the shells for the muzzle-loading shunt gun were slightly bruised, but not sufficiently to render them unserviceable.

There were no apparent defects in the body of any of Colonel Boxer's shrapnel shells.

The Committee have to observe that several repairs became necessary in the limber boxes whilst travelling, and that when such repairs become necessary or the packing becomes loosened, the lead coated projectiles for the breech-loading gun are more liable to injury than the others, and that the Whitworth projectile, as presenting a smooth external surface of hard metal, is the least liable to injury externally from rough usage.

The Committee further tested the projectiles for the three guns by placing 10 rounds of shot, common segment and shrapnel shell in wet straw, and periodically wetting the straw with fresh and salt water for six months, these projectiles were not in any way damaged, and were subsequently fired.

With respect to the stripping of the lead from the projectile of the B. L. Armstrong gun, the Committee have to report that, except when fired without either lubricators or water, no such liability has been observed during their experiments.

Various opinions having been brought before the Committee in the course of their inquiries as to the liability of the different projectiles to injury from the influence of climate when kept in store for long periods, they referred specimens of each to Mr. Abel, F.R.S., the chemist to the War Department, for his opinion on this point.

He reports, "There can be no question as to the permanent characters of the Armstrong muzzle-loading shell and the Whitworth shell; the only precaution to be attended to in their preservation in any climate being the renewal of the lacquer as soon as it no longer effectively protects the external surfaces of the metal from rust."

He is "also of opinion that the Armstrong breech-loading shell as now manufactured will not be found susceptible of deterioration. The liability of the soft metal coating to separate from the body of the shell, in consequence of different effects of heat upon the two metals, and of the non-elastic nature of the soft metal, has been entirely overcome by soldering the metals together through the agency of zinc. Instances have occurred in which a separation of the metals in a few very small places has been observed some time after the projectile had been in store, a result which was traced to the accidental enclosure of minute quantities of saline matter between the metals, whereby a voltaic action was established."

He believes "that the possibility of this occasional trifling separation has been set aside in the manufacture of the projectiles in question, but even where it has occurred it has never been detrimental to the efficiency of the ammunition."

"The superficial oxidation, which the soft metal undergoes within a short period after the completion of the projectiles, affords the best possible protection against continued atmospheric action; it is only further essential to their proper preservation to protect the exposed iron portion by means of lacquer, and to extend the coating of the latter on the soft metal to such an extent as to ensure the covering of the exposed points of junction between the two metals."

The Committee, with a view to reporting in accordance with their instructions on the comparative cost of the projectiles, so far as can be ascertained before their manufacture has been systematically established, called upon the Superintendent of the Royal Laboratory for a statement of the cost of the labour and material in the various projectiles, exclusive of all contingent expenses, such as cost of machinery, interest on capital, &c. &c.

The whole cost is constituted of labour, materials, and contingent expenses; the item of labour may be described as in part hand labour and in part machine labour, and the amount of machine labour varies in the competitive projectiles. It being, however, impossible for the Committee to ascertain the relative cost of machine labour in each case, and as the contingent expenses appear equal in all cases, the Committee have included in the following figures the items of material and hand labour only.

The principal projectiles for field service are the segment and shrapnel shells; the cost of these may be separated under three heads:—

1st. The body of the shell, which in all cases is of cast iron and nearly of the same weight, and which may therefore be assumed to cost in its rude state about the same amount for each system.

2nd. The labour and materials expended in adapting the exterior of the cast-iron projectile for use from the rifled bore.

3rd. The internal fitment of the shells.

The total cost of hand labour and materials per 100 shells has been stated to the Committee to amount, for—

|                                     | £  | s. | d. |
|-------------------------------------|----|----|----|
| The breech-loading Armstrong gun to | 11 | 1  | 0  |
| Whitworth - - - - -                 | 13 | 19 | 9  |

No segment shell have been made for the muzzle-loading Armstrong gun in the Royal Laboratory. Upon more particular inquiry from Colonel Boxer, the Committee have ascertained that the cost of preparing the exterior of the shells for firing under the 2nd head, as stated above, would be as follows for 100 rounds :—

|                                            | £ | s. | d. |
|--------------------------------------------|---|----|----|
| For the breech-loading Armstrong - - - - - | 4 | 13 | 0  |
| „ Whitworth - - - - -                      | 1 | 2  | 11 |
| „ muzzle-loading Armstrong - - - - -       | 2 | 0  | 7  |

With respect to the above prices, the Committee have to observe that the cost of preparing the breech-loading Armstrong projectile is that which has been established after making these projectiles for the service on a large scale in a well appointed factory.

With respect to the cost of preparing the Whitworth projectile, the Committee have to observe that it is derived from a limited manufacture of experimental projectiles, and that if Mr. Whitworth's estimate of the cost of planing be assumed in lieu of that given in the Royal Laboratory, and which the Committee consider would be a not unreasonable rate under the supposition that the manufacture was well established, the cost of preparing these projectiles would be reduced very considerably.

The cost given for preparing the muzzle-loading or shunt projectile is composed of two elements :—

|                                   | £ | s. | d. |
|-----------------------------------|---|----|----|
| Cost of copper in studs - - - - - | 0 | 15 | 7  |
| Labour in fixing studs - - - - -  | 1 | 5  | 0  |
| Total - - - - -                   | 2 | 0  | 7  |

These amounts have also been derived from the manufacture of a small number of experimental projectiles. The Committee observe that it is probable also that this amount may be much reduced as regards labour, but that the cost of the copper must always remain a large item in the preparation of these projectiles, varying with the value of copper in the market.

Making every allowance for reduction in hand labour consequent on the systematic establishment of the manufacture, the Committee are of opinion that, considering the compound nature of Sir W. Armstrong's projectiles, these projectiles must be more expensive than the Whitworth projectile, and both will be very considerably less expensive than the breech-loading projectile.

With respect to the expense under the third head, the internal fitment of the segment shell, the Committee have ascertained that the fitments in the shrapnel shell cost 5*l.* 13*s.* per 100, whereas those in the segment shell cost only 2*l.* 6*s.*

The Committee tested the various time fuzes submitted to them by firing five rounds from each gun at elevations of 3°, 4°, 5°, and 6°, noting carefully by stop-watches the time which elapsed between the explosion of the gun and the bursting of the fuze.

The whole were detonating time fuzes; those fired from Sir W. Armstrong's guns having been designed and made by him, whereas those fired from Mr. Whitworth's guns were designed by Colonel Boxer, R.A., and made in the Royal Laboratory.

The mean differences in the times of burning of the fuzes were as follows :—

|                          |                                   |
|--------------------------|-----------------------------------|
| Breech-loading Armstrong | 0·36 seconds, with 5 blind fuzes. |
| Whitworth - - - - -      | 0·24 „ 2 „                        |
| Muzzle-loading Armstrong | 0·10 „ none blind.                |

At Sir W. Armstrong's request the Committee fired 47 special fuzes from the muzzle-loading gun with covers slightly different from those of the fuzes with which the competitive experiments had been made; the mean difference in the times of burning of these fuzes was 0·08 second, with none blind; this is practically the same result as that obtained with the other fuzes from the same gun.

These results give a good idea as to the burning of the fuzes. The Committee point out that Sir William Armstrong's time fuze has the advantage of being capable of being



adjusted up to the moment of firing, and of the adjustment being inspected after the fuze is fixed in the shell, also of being employed in combination with the percussion fuze; the regularity of all is very good.

The Committee tested the percussion fuzes by firing them against objects which afforded a direct resistance to the projectiles, and found that all of them when so fired answered perfectly, Colonel Boxer's being slightly less sensitive.

They also caused a number of rounds to be fired so as to test their efficiency when used to burst shells grazing on water or sand, the results of which are as follows:—

| Description of Gun.        | Grazing on Water. |       |        | Grazing on Sand. |       |        |
|----------------------------|-------------------|-------|--------|------------------|-------|--------|
|                            | No. of Rounds.    | Good. | Blind. | No. of Rounds.   | Good. | Blind. |
| Breech-loading Armstrong - | 16                | 13    | 3      | 10               | 9     | 1      |
| Whitworth -                | 16                | 16    | 0      | 10               | 4     | 6      |
| Muzzle-loading Armstrong - | 16                | 15    | 1      | 10               | 10    | 0      |

From these trials it appears that when grazing on water Colonel Boxer's percussion fuze, as fired with the Whitworth projectile, acts rather better than Sir W. Armstrong's percussion fuze, but that when grazing on sand Sir W. Armstrong's has a decided advantage over Colonel Boxer's percussion fuze.

The Committee caused a number of each description of fuze to be packed and travelled a distance of 200 miles in ordinary limber boxes. The results were as follows:—

The waterproof paper bags, in which it is necessary that Sir William Armstrong's time fuzes should be packed, were in nearly all cases cut by the edge of the tin boxes; in three out of thirty fuzes travelled the priming was partially shaken out, the needles were *all* found to be very much corroded, and in two cases they were very nearly eaten away.

Sir William Armstrong's percussion fuzes were not injured by travelling.

Colonel Boxer's time and percussion fuzes were all found not to have been injured by travelling; but it is to be observed that an alteration had been made to these fuzes prior to this experiment, and unknown to the Committee, by the addition of a piece of kampfuticon at the base of the fuze.

The Committee also submitted specimens of all these fuzes to Mr. Abel for examination and report as to their probable durability when subject to the constantly changing effects of climate.

Mr. Abel reports that, "the Armstrong time fuze is unquestionably more susceptible of deterioration than any of the other descriptions of ammunition submitted to him."

"The fuze composition, though protected by means of a coating of paper and by the leather washer which is fixed into the cap, is still sufficiently accessible to moisture to render it very liable to serious deterioration by a protracted preservation of these fuzes in damp localities. The priming contained in the annular recess just below the nut, and also the priming pellet in the cap, are still more open to injury from damp than the fuze composition. After the exposure of a fuze of this description for one month to a moist atmosphere, the temperature of which ranged from 90° to 120° of Fahrenheit, the priming compositions were found to have become so much injured as to burn with very great difficulty. Another portion of this fuze which is likely to become injured by time, although it is excluded from the effects of atmospheric moisture by enclosure within the body of the fuze, is the iron pin which serves to ignite the detonator.

"The small quantity of priming which is fixed round the base of that pin, and in actual contact with it, cannot fail to corrode the iron; an oxidizing action being established by the small quantity of moisture present originally and unavoidably in the composition.

"The pin of the fuze examined by him was much rusted, and the rust had penetrated to a considerable extent into the composition, interfering with its inflammability.

"Judging from the appearance of the pin and of the slight force requisite to break it (the thickness of the metal having been much reduced by corrosion)," he considers "it likely that these pins will frequently be corroded to such an extent as at any rate to destroy their points, and to deprive them of the power of perforating the detonators.

"It is evident that these particular fuzes must be preserved in store in perfectly waterproof cases, but even this precaution will not prevent the deterioration of the igniting arrangement consequent upon the contact of the iron pin with priming composition."

This opinion of Mr. Abel is fully confirmed, so far as it applies to the needle or iron pin which serves to ignite the composition, by the effects before stated as having been

observed in the ammunition which had been travelled, and in which the fuzes having been quite new the corrosion had taken place in the very short period during which they had been exposed to the chances of service in this climate.

The Committee, however, have to observe that while their report was under consideration, Sir W. Armstrong proposed to substitute a brass for the iron pin, which Mr. Abel considered would obviate this defect, but they had no opportunity of trying any of this new pattern of fuze. Mr. Abel further reports that Sir W. Armstrong's percussion fuze does not appear in any way liable to deterioration.

Mr. Abel reports on Colonel Boxer's detonating wood fuze that "it is naturally susceptible of alteration in its external dimensions from the swelling or shrinking of the wood in very damp or dry and warm situations. In one month's exposure of one of these fuzes to a warm moist atmosphere, the wood had swollen sufficiently to loosen the paper which bears the numbers and is fastened over the holes provided for setting the fuze.

"This loosening and possible detachment of the index is the only inconvenience likely to result from the effect of climate upon the fuze, and may be overcome without difficulty. By the paper lining inside the fuze any slight changes which the wooden case may undergo for a time in its dimensions are prevented from interfering with the efficiency of the fuze. The priming contained in the small perforations and in the end of the fuze appears to him to require more permanently efficient protection from the effects of moisture than that afforded by the thin painted paper coverings, which are liable to become loosened. This could obviously also be accomplished readily;" and he is of opinion that there would then be no part vital to the efficiency of this fuze likely to suffer deterioration.

Mr. Abel further considers that Colonel Boxer's metal percussion fuzes "are as little susceptible of deterioration by being kept in store in different climates as Armstrong's pillar fuzes," the construction of which he reports to be "perfectly calculated to ensure permanent efficiency under all climatic conditions." He has only "to observe with reference to them, that the small piece of paper or gutskin, coated with shellac, which is fixed upon the perforation at the bottom of the fuze, cannot be nearly so efficient in permanently excluding moisture from having access to the interior of the fuze as the thin plates of metal employed for closing the perforations in the bases of the Armstrong fuzes referred to above."

The Committee have ascertained from the Superintendent of the Royal Laboratory that the cost of labour and materials expended in making these fuzes is as follows:—

|                                                  |   |   |   | Per 100. |    |    |
|--------------------------------------------------|---|---|---|----------|----|----|
|                                                  |   |   |   | £        | s. | d. |
| For Sir W. Armstrong's time fuzes                | - | - | - | 4        | 13 | 11 |
| "                    "          percussion fuzes | - | - | - | 3        | 6  | 6  |
| Total per 100                                    |   |   |   | 8        | 0  | 5  |
| For Colonel Boxer's time fuzes                   | - | - | - | 2        | 8  | 8  |
| "                    "          percussion fuzes | - | - | - | 2        | 11 | 2  |
| Total per 100                                    |   |   |   | 4        | 19 | 10 |

These figures exhibit a difference in cost of 3*l.* 0*s.* 7*d.* per 100 in favour of Colonel Boxer's fuzes.

The Committee consider that the results of the practice with Sir W. Armstrong's and Colonel Boxer's time fuzes show that they are for all practical purposes equally regular in their times of burning; they, however, consider that the Armstrong time fuze is more complicated and expensive, that it requires more care in packing, that it possesses certain defects, which, as reported by the chemist to the War Department, render it liable to deterioration, although probably some portion of these defects might be remedied; they at the same time most fully appreciate the very great advantage that accrues to the Armstrong fuze from the fact of its being capable of adjustment after being screwed into the shell, and being used in combination with the percussion fuze; and having most thoroughly weighed and considered the entire subject, they are of opinion that Colonel Boxer's time fuzes are superior to and better adapted for the service than Sir W. Armstrong's time fuzes.

The Committee have further to report that they consider that Sir W. Armstrong's percussion fuze gave on the whole most satisfactory results, and Colonel Boxer's percussion fuze satisfactory results on water and against upright obstacles, but not satisfactory results on graze, which latter they consider in some respect probably due to



the form of the projectile ; and having considered the construction of the fuze, and the entire subject in all its bearings, they are of opinion that there is no decided superiority in one fuze over the other.

The Committee having thus given their opinion in detail on the several points referred to them by their instructions with respect to the field guns and their ammunition, have now the honour to report that they are of opinion that both Sir W. Armstrong's and Mr. Whitworth's muzzle-loading systems, including guns and ammunition, are on the whole very far superior to Sir W. Armstrong's breech-loading system for the service of artillery in the field, and that the latter has the advantage of being better adapted for boat service.

With respect to the two muzzle-loading systems, the Committee are of opinion that Mr. Whitworth's and Sir W. Armstrong's guns have proved themselves during the course of their experiments both powerful and efficient for service under all conditions, but in balancing their relative advantages the Committee have to report that the rival systems as submitted to them differ in the following important points :—

1st. Form of bore.

2nd. Rapidity of twist in rifling.

3rd. Calibre, length, and weight.

4th. Iron projectiles with smooth surfaces as compared with projectiles composed of iron with brass studs.

5th. Manufacture of gun, whether entirely of one metal or of one metal superimposed upon another.

The Committee have had these various points of difference submitted to them in a combined form by Sir W. Armstrong and Mr. Whitworth, but not having been empowered to impose restrictions upon the two competitors, they have not been able to work out exact results on each point.

They have, however, to report—

1st. With respect to form of bore, that the Whitworth is more simple, but that both forms are practically sufficient for producing the required rotatory motion in the projectiles.

2nd. As regards rapidity of twist, the results have proved that both guns had a twist which ensured accuracy of fire to the limits within which field artillery is ever used on service, but the Committee could not determine from their experiments whether either of the systems would be improved by a variation from the twist adopted in the guns which have been tried by the Committee.

3rd. With regard to calibre, that as the weight of the projectile for field service is determined by the conditions of transport, it matters little whether the projectile within that weight varies in calibre within the limits proposed by the two competitors, especially as the capacity of common shells of small calibres is insignificant.

With respect to length and weight, the Armstrong muzzle-loading gun is  $8\frac{1}{4}$  inches shorter and one cwt. lighter than the Whitworth gun, and is so far more handy for service.

4th. The experiments made by the Committee have clearly demonstrated that with the form of rifling proposed by Mr. Whitworth when applied to a mild steel or homogeneous metal gun, hard metal projectiles can be fired from 12-pr. rifled guns without the intervention of any soft metal between the projectile and the bore ; that they do not damage the bore, are equally accurate in their flight, less liable to injury from rough usage, and also possess the advantage of greater economy as compared with the projectiles fired from Sir W. Armstrong's shunt gun, which, as the cost of ammunition is a continual recurring expense, is an item of great importance : on the other hand, the system of soft metal studs as applied in Sir W. Armstrong's shunt gun, empowers the use of the cylindrical or most capacious form of projectile, which, however, in field guns is of no great importance ; it also provides the projectile with a certain power of self-adjustment.

On the whole, other things being equal, the Committee are of opinion that of the two projectiles that which is of one simple metal is to be preferred.

5th. With respect to the manufacture of field guns, the Committee are of opinion that the steel as furnished by Sir W. Armstrong and Mr. Whitworth for these trials has answered perfectly as regards the bores, and is thoroughly trustworthy for the interior of a gun, and that it possesses great advantages when so used. The homogeneous metal or mild steel in the Whitworth gun being of greater thickness and weight proved itself more enduring than the structure of steel combined with iron in Sir W. Armstrong's gun ; and although it would probably have lasted for an indefinite number of rounds with the full service charge, it finally burst in a violent manner such as would have been attended with destruction to the men serving the gun.

Although the experiments have proved that this metal can be made of ample strength, the Committee hesitate, in the present condition of the manufacture of steel, to recommend the adoption of that metal alone in the construction of field guns, in consequence of their very limited experience as to the certainty of the manufacture of this material, and the violence with which Mr. Whitworth's gun burst.

The experiments have also proved that wrought-iron coils placed over steel afford a very secure structure, and by giving indications of approaching fracture, or by merely splitting, are calculated to secure the confidence of the men who serve the guns.

The whole question of material, however, embraces so many considerations of safety, strength, simplicity, economy, certainty in manufacture, and even of progressive improvement, that the Committee cannot at present pronounce more categorically on this head.

(Signed) R. RUMLEY, Major-General, *President*.  
A. J. TAYLOR, Major-General, R.A.  
J. W. ORMSBY, Colonel, R.A.  
T. WILSON, Captain, R.N.  
J. L. A. SIMMONS, Colonel, R.E.  
M. SINGER, Commander, R.N.  
C. F. YOUNG, Major, R.A.  
J. C. McDONALD.  
S. RENDEL.

H. C. S. DYER, Captain, R.A., and Major,  
*Secretary.*

109, Victoria Street, London.  
April 19th, 1865.

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SIR,

Horse Guards, April 27, 1865.

As I find the proceedings of the Armstrong and Whitworth Committee have not as yet been submitted to the Secretary of State for War, together with the Report on the 12-pounder competitive guns, and considering that my signature, in the absence of any evidence to the contrary, may be taken as implying concurrence with the opinions therein expressed *without exception*, I am under the necessity of requesting that the accompanying copy of the amendments I proposed on the occasion of the last meeting of the Committee may be submitted for the consideration of the Right Hon. the Secretary of State for War.

I find that in former Committees of a similar character the opinions of the several members were separately expressed and attached to the final Report, thus showing the reservations under which their signatures were attached to the general summary, and I claim to be allowed to place on record the instances in which I have found myself unable to concur in the verdict of the majority and my reasons for the same.

I need not add that in signing the Report in its present form I did so under the full persuasion that I was only doing my duty in accepting the decisions of *a majority*.

Had I been aware of the existence of the precedents I have above quoted, I should not have confined myself to insisting on my amendments appearing in the proceedings.

I have, &amp;c.

(Signed) A. J. TAYLOR,  
Major-General,  
Inspector-General of Artillery.

Major-General R. Rumley,  
President of the Armstrong and  
Whitworth Committee.

AMENDMENTS proposed by myself on Report of Competitive 12-Pr. Rifled Field Guns,  
April 1865.

Page xlvii., paragraph 1, 3rd line.—After the words “they are of opinion,” to leave out to the end of the paragraph, and in lieu thereof to insert the words, “That after a careful weighing of all the considerations involved, *the balance of advantage* rests with the two muzzle-loading guns; but the Committee think it due in summing up to record their recognition of the following advantages attaching to Sir W. Armstrong’s breech-loading 12-pr. as submitted:—

“*First.* Its lightness, being half a cwt. lighter than the shunt, and one and a half lighter than the Whitworth.

“*Secondly.* Its greater adaptability, for this and other reasons before detailed, for boat service.

“*Thirdly.* The facility its construction affords for constant watching of the state of the interior of the bore; an undoubted necessity of rifled guns, and involving with muzzle-loaders a somewhat troublesome process in the field.

“*Fourthly.* The impossibility of spiking it by an enemy in temporary possession of it, while the removal of the vent pieces renders it as useless to him as if spiked.

“*Fifthly.* This point was not included in my proposed amendment, but my remarks on it were read in detail to the Committee, ‘greater rapidity of fire in cases of special emergency.’” (Case shot.)

Page xlii. of Report, paragraph 4, line 2.—After the words “Colonel Boxer’s shrapnel shells,” to leave out to the end of the paragraph, and in lieu thereof to insert, “The Committee have to observe that the result of their experiments go to prove that Colonel Boxer’s shrapnel, when burst by time fuze in the air during flight, especially at distances considerably short of the object, has a decided advantage over Sir W. Armstrong’s segment shell as regards the penetrative power of the bullets it contains, and their farther range after release; but that this projectile, fired to *graze* in front of an object whenever burst, has produced very inferior results to those of Sir W. Armstrong’s segment shell *burst as he proposes*, while the number of instances in which the former projectiles have grazed at short ranges without exploding at all, show that from causes which *may* have reference only to the external form of

This appears in the body of the Report, but without comment.

To this may be added, that without vent pieces, which an enemy would find it difficult to extemporize, the gun remains useless to him for the campaign.

I dissent from the opinion that this mode of firing involves “risk” if the commonest care is used.

See page xxxviii., paragraph 1.

the shell, and *may or may not* be remediable, their action in this respect in combination with Mr. Whitworth's gun is not in their present condition *effective for field service*.

*Page xlii., last paragraph.*—I consider that until Colonel Boxer's percussion fuze gives equally good results with that of Sir W. Armstrong on graze, it is in this respect *unquestionably inferior*, and I therefore dissent from this opinion as expressed here.

(Signed) A. J. TAYLOR,  
Major-General,  
Inspector-General of Artillery.

SIR,

Woolwich, May 4, 1865.

I HAVE the honour to request you will be good enough to submit to the Right Honourable the Secretary of State for War the following remarks, having reference to the preliminary Report of the Armstrong and Whitworth Committee. I signed that Report as I agreed generally with its contents, although I consider that in treating of the merits and demerits of the systems in competition many very important particulars have been omitted. I beg, therefore, most respectfully to point out,—

1st. That I do not concur with the statement made in page xliii. of the Report, viz., "With respect to form of bore, that the Whitworth is more simple." On the contrary, it is my opinion that the Whitworth is far more complicated, and that it is altogether an objectionable form of bore of a rifled gun for the following reasons:—

I. Its departure from the best form, or cylinder being so great.

II. Its liability to foul.

III. The angles which such a form presents, and which must assuredly give lines of weakness to both guns and projectiles.

2ndly. As regards rapidity of twist, it is stated that both guns had a twist which ensured accuracy of fire, &c. Now, as the Whitworth gun has nearly double the twist of the Armstrong guns, I think the following should have been added as an important feature in favour of the latter guns, viz., that it is most undesirable to give a greater twist to a rifled gun than is absolutely necessary to ensure accuracy of flight to the projectiles; 1st, on account of the strain on the gun increasing with the twist; 2ndly, the greater tendency to deflect on ricochet which a rapid twist gives to the projectile.

3rdly. With regard to calibre, I would observe that Mr. Whitworth is a great advocate for small bores, which appears to me erroneous in principle, the useful effect of a given charge of powder being thereby reduced and the capacity of the shell diminished.

4thly. The taper in rear which Mr. Whitworth has given to his projectiles with a view of increasing their range seems to me objectionable on the following grounds:—1st, by reducing the capacity of the shells; 2ndly, being a form likely to cause the inflamed gas to act injuriously on the gun; 3rdly, causing great deflection on graze, rendering the percussion fuze almost useless in the field.

I had intended waiting until the completion of the Report before submitting the foregoing remarks, showing the points in which I differ from the majority of the Committee, but on reconsideration I think it better they should be made known to the Right Hon. the Secretary of State for War whilst the preliminary Report is under his notice.

I have, &c.

(Signed) CHARLES F. YOUNG,  
Captain R.A., and Major.

Major-General Rumley,  
President of the Armstrong and  
Whitworth Committee.



SIR,

London, May 19, 1865.

WHEN I signed the preliminary Report on the 12-pounders, I signed it subject to the differences of opinion expressed by my vote in the numerous (72) divisions recorded in the Committee's proceedings, and upon the understanding that the proceedings would be read with the Report. I find that this course is not strictly in accordance with the practice of Committees appointed by the Secretary of State, and that dissentient members usually state separately the reservations subject to which they sign. I have the honour, therefore, to request that the following remarks may be appended to my signature to the Committee's preliminary Report.

I. I dissent generally from the "analysis" of oral evidence contained in pages vi. to xii. of the Report inclusive, which appears to me rather a Report founded on that evidence than an analysis of it. I consider that the instructions of the Committee directed them to take the evidence in question for their guidance in the forthcoming inquiry, not as the material for a retrospective Report. In itself it is, I think, far more favourable to Sir W. Armstrong's guns than appears by the analysis; but, at any rate, before it was used for the purpose of a Report the competitors should have had an opportunity of replying to the adverse portions of it, especially as they had a right to expect that the Committee would confine their Report to the guns and ammunition submitted to competition. By travelling backwards the Committee appear to me, in effect, to prejudice the case submitted to them, and, as the antecedents of Mr. Whitworth's guns have been unavoidably kept out of sight, that prejudice operates against Sir W. Armstrong solely. As an example, I cite the following paragraph from page vii. :

"These Reports, which are the recorded evidence of a very limited use of the breech-loading Armstrong gun with old pattern vent pieces on active service, may be considered as indicative only of what might be expected in more serious affairs, such as a general action or decisive battle, in which a numerous artillery would be employed; combined with other evidence they tend to show that the vent piece is an element of insecurity which has been found objectionable even at practice, and may therefore be expected to be much more so in the hurry and excitement of action."

It is impossible that this paragraph can have any reference to the vent pieces actually submitted to the Committee by Sir W. Armstrong, for the Committee's experience of these vent pieces, as reported by them further on, carries a completely contradictory conclusion; and yet it cannot be denied that the effect of the paragraph is to prejudge the vent piece question generally.

I object also to the manner in which suppositions have been brought forward in this analysis to the prejudice of admitted facts. Thus in the paragraph at page x. relating to the pillar fuzes the analysis records the facts that they "answer well in firing," and that there is "no evidence of any accident having occurred with them on service or in practice;" but these facts are supplemented as follows:—

Report, p. x.  
See also p. viii.  
(last paragraph).

"These fuzes are also considered as too delicate and liable to accidents by Colonel Boxer, R.A.; and Captain Bent, R.A., the Assistant Superintendent of the Laboratory at Devonport, stated in February 1863, that they had been in the service some year or year and a half, but in the course of that time they became so fixed in the shell that it is very dangerous indeed to remove them; he added, however, that 'none had exploded.'"

I think that these conjectures should not have found a place in the Report. Colonel Boxer has been referred to and accepted by the Committee as Sir W. Armstrong's competitor in fuzes. Captain Bent's fears, which concern not the fuze, but the then prescribed mode of fixing it, are admitted to have no foundation in fact.

II. I consider that the Report does not sufficiently guard against undue weight being given to the results obtained in range and accuracy with solid shot. Solid shot are not, nor is it suggested that they ever will be, used with rifled field pieces in the British or any other service. For such guns they are purely experimental projectiles, and they have been employed by the Committee solely for the sake of economy. Had the results obtained with them accorded, as was expected, even approximately with those obtained with shell, they would have been of some value, but, as it is, these results appear to have a high value from their prominence in the Report, whereas they have in reality none at all. This is the more unfortunate because Sir W. Armstrong has never proposed solid shot for field guns, and because the Committee are aware that in the case of the 70-pounders, for which guns Sir W. Armstrong does propose shot, there is no discordance of results in range and accuracy between his shot and shell.

Rep., p. xix. III. While I consider that undue prominence is given to the solid shot practice, I think that it is not made sufficiently clear in the Report, that up to 5° elevation, or over 2,200 yards range, the muzzle-loading Armstrong 12-pounder is with both segment and common shell superior to the Whitworth in range, and is with segment shell "practically equal," and with common shell superior in accuracy. I consider these facts of importance, because a range of 2,200 yards may be regarded as the maximum range ordinarily required in the field, and is certainly the longest at which segment or shrapnel shell could be used with effect.\* At 10° elevation, or 3,600 yards range, the muzzle-loading Armstrong 12-pounder is with segment shell at least equal in accuracy and only 100 yards inferior to the Whitworth 12-pounder in range, an inferiority inappreciable at that distance, and in no way counterbalancing its superior range and velocity within all reasonable fighting limits.

Rep., p. xxiv. IV. I consider that the recorded insufficiency of strength in the shrapnel shell as adapted to Mr. Whitworth's rifling and form of projectile requires additional comment. The external metal of this shrapnel shell is already half again as thick as that of the Armstrong segment shell, and yet, "18 out of 112 shrapnel shell broke up in the bore of the Whitworth gun," and, on one occasion, "11 out of 20 upon graze" on sand. The same defect has been shown to about the same extent in the shrapnel shell of Mr. Whitworth's 70-pounder gun. Thus, irrespective of the reduction of capacity due to the smaller bore advocated by Mr. Whitworth, and the reduction already made by the increase in the thickness of the metal case, a further reduction will be necessary before this projectile could be employed on service, whereby its capacity, whether for bullets or segments, will become very inferior to that of the Armstrong shell. I consider that the angular form of bore and projectile, together with the quick twist and small calibre of Mr. Whitworth's gun, are seriously prejudicial to the strength and capacity of the shell, and render this gun inferior as a field gun with which shell only are employed.

See also Colonel Boxer's evidence, q. 1733, p. 63. Rep., p. xxxviii. V. The Report, after observing that Colonel Boxer's shrapnel shell "as fired from Mr. Whitworth's gun is far inferior to Sir W. Armstrong's segment shell," when both are burst on graze, as is the usual practice with the service field artillery, states that "taking into due consideration the fact that the principle of the shrapnel shell is not confined to the form of shell used in the Committee's experiments, the Committee (*i.e.*, the "majority") prefer the shrapnel." I dissent from thus reporting in favour of a "principle." I think that the Committee have to do with the shrapnel shell as fired from Mr. Whitworth's gun, and not in any other and better form. If the principle of the shrapnel does not have justice done it when adapted to Mr. Whitworth's system, then it is for the Committee, in my opinion, to say that Mr. Whitworth's system is in fault, and not that Colonel Boxer's principle is right. But to draw the latter theoretical deduction without even plainly stating the former practical conclusion is, I think, a double error. Mr. Whitworth's system may thus appear to obtain credit instead of discredit from Colonel Boxer's shell.†

Records of experiments, p. 291. VI. I cannot agree to any Report upon Colonel Boxer's time fuzes founded on the experience of 30 rounds divided between two varieties of fuze. Sir W. Armstrong's time fuze differs from Colonel Boxer's only because he seeks to secure certain important additional advantages. These advantages I venture, on the highest authority, to consider essential to a naval time fuze. I believe them to be of such importance to land service fuzes, that they should not be relinquished for anything short of inherent defect. But the only defect reported in the Armstrong time fuze is one shared by the Boxer time fuze, *viz.*, liability to deteriorate unless further protected, and this defect is admitted to be remediable alike in both.

Rep., p. xli. The Committee did not test the Boxer fuzes as submitted by "travelling them," those actually travelled being, without the knowledge of the Committee, of a different and more recent pattern specially prepared to resist this test. On the other hand, the great improvements made during the past two years in Sir W. Armstrong's time fuzes have, unavoidably perhaps, not been recognized.

Rep., p. xli. VII. As Colonel Boxer's percussion fuze is admitted to be less sensitive than Sir W. Armstrong's percussion fuze, and as it has almost invariably failed to act on graze at 800 yards range and under, I cannot agree to the opinion that "there is no decided superiority" in the Armstrong fuze. I think also that the Committee should have pointed out that Colonel Boxer's percussion fuzes require the resistance afforded by

\* In the French service the limit prescribed for the use of the obús à balles or shrapnel is 1,200 metres.

† Of the 14 shrapnel shell fired from the Whitworth 12-pr. and burst by graze upon the ground, five produced no result of any kind. These experiments were discontinued.—*Vide* Records of Experiments, p. 288-290.



three inches of timber to explode them with any certainty, so that there is little, if any, chance of their taking effect upon striking a man or a horse.

VIII. As to the comparative cost of the respective shells and fuzes, I must dissent from the propriety of the Committee's Report resting solely upon Colonel Boxer's opinions, he being Sir W. Armstrong's admitted competitor with respect to them.

IX. With regard to the Committee's conclusion as to the breech-loading Armstrong 12-pounder, I consider that this gun is admitted to fulfil all possible requirements as to range, penetrative power, and endurance. It is more accurate than either of the muzzle loaders with segment shell, and than the Whitworth with common shell at the elevations up to 5°, which include all practically useful ranges. With the segment shell of corrected gauge it is greatly more accurate. Its initial velocity is with equal charges superior to that of the Whitworth. In ease of working "there is no practical difference" between it and the two muzzle-loading guns so long as lubricators or water are used, (and it should be remembered that Mr. Whitworth has not proposed to do without lubrication, but, on the contrary, has fired every one of the 3,000 rounds from his A. 12-pounder gun with a copper lubricator filled with linseed oil). In rapidity of fire it has proved itself three times superior to the muzzle-loading guns without any appearance of risk, to realize which advantage in action it is only necessary to conform to the 40-pounder service drill. Under the head of "capability of standing rough usage," the Report states that "all three guns are equal to the performance of the duties that may be required of them." The breech-loading apparatus has never been in any way injured, and has with the vent piece "outlived the gun." It has been found impossible to\* blow out the vent piece or break it. The projectiles are reported to be "not susceptible of deterioration," and have not been rendered unserviceable under any test. The lead coating has not stripped nor proved in any way disadvantageous. The gun has continued in the highest state of efficiency for 3,000 rounds without being refaced more than once in every 466 rounds, the Whitworth having been re-vented once in every 350 rounds. Lastly, it is very considerably the lightest gun, the Whitworth being 20 per cent. heavier. All these facts appear in the Report of the Committee, and I think that the very favourable conclusions to which they lead should have been more prominently recognized especially considering the injustice which they show to have been done to the system in the preliminary analysis of oral evidence. That the Committee have no fault to find with the breech-loading Armstrong 12-pounders is proved by their pointing out its advantages for the naval service as a boat gun. The only objection to it is, as I understand the Report, that it is not a muzzle loader.

X. As to the two muzzle-loading 12-pounders, I think that more stress should have been laid in the Report on the fact that the Whitworth 12-pounder is 14 per cent. heavier and 9 per cent. longer than the Armstrong. So marked a difference in weight and length, and consequent handiness and portability, is in field service guns a consideration of manifestly first-rate importance.

XI. I think also that in stating the relative advantages of iron-fitting projectiles and projectiles rifled by the compression of soft metal studs it should have appeared in the Report that the latter system involves less departure from the cylindrical or strongest and most serviceable form of bore, empowers the use of the cylindrical or strongest and most capacious form of projectile, and also in large calibres of round shot, causes the minimum wear to the bore, and is thus more applicable to wrought-iron and brass guns, and provides the projectiles with a power of self-adjustment to the bore, rendering it independent of errors of manufacture, rust, or external injury, and of accidental obstructions in the bore. These facts appear to me essential to a fair comparative statement of the differences of the two systems, and as they were attested by ample authority within the Committee itself, I must most respectfully protest against their having been almost completely excluded from the Report by the vote of the barest majority.

XII. Finally, I think that misapprehension may arise upon the following passage owing to the position which it holds in the Report.

"On the whole, other things being equal, the Committee are of opinion that of the two projectiles that which is of one simple metal is to be preferred."

I agreed to this paragraph on the ground that it must be accepted as an abstract proposition. I must therefore be allowed to point out that the paragraph is not to be interpreted as a direct or indirect expression of preference for Mr. Whitworth's projectiles, but simply as the expression of an abstract opinion in favour of projectiles of one metal, provided that other things are equal.

\* After their Report was signed, the Committee fired five rounds from the Armstrong 12-pr. breech-loader, with the vent-piece left loose and wholly unscrewed up. It did not blow out.

The proceedings of the Committee prove indisputably that this latter is the true interpretation, for they show that the paragraph is the substitute for another of different wording, which was carried, but afterwards unanimously struck out on the ground that it was capable of being interpreted in favour of Mr. Whitworth's projectiles, and that that was *not* the meaning of those who voted for it.

To the President,  
Special Armstrong and  
Whitworth Committee.

I have, &c.  
(Signed) STUART RENDEL.



## 70-POUNDERS.

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THE Armstrong and Whitworth Committee have now the honour to present the following in continuation of their former report of the 19th April 1865. In that report they gave an epitome of the evidence they had been able to collect bearing upon the questions referred to them up to the period at which their investigation was commenced, and a statement of the reasons which guided them in the selection of 70-pounders for the experiments which they proposed to undertake to test the relative merits of the three systems of artillery submitted to them.

The Committee further gave a statement (p. xvi.) of the dimensions of the guns and ammunition delivered to them by Sir William Armstrong and Mr. Whitworth for experiment, and then proceeded with the details of the experiments made with the 12-pounders for the elucidation of the merits of these systems as applied to Field Artillery.

The Committee propose now to continue the report of their proceedings, by detailing the results of the experiments with the 70-pounders.

The breech-loading Armstrong 70-pounder guns submitted to the Committee were constructed, two of them of steel inner tubes or barrels of 1 and  $1\frac{3}{4}$  inches thickness respectively, with wrought-iron coils super-imposed, and the third of wrought-iron coils; but before commencing the experiments Sir William Armstrong stated to the Committee, that he considered that the trial for endurance would be more satisfactory if carried out with the gun having the thick steel barrel; the Committee had consequently no opportunity of testing for endurance the merits of barrels composed of wrought-iron coils.

These breech-loading guns were all made upon the wedge system, which, as stated in their former report, Sir William Armstrong now proposes for all breech-loading guns of higher calibre than the 40-pounder.

As an example of the correctness of the view expressed by Sir W. Armstrong, that the side wedge loading system is preferable for all large breech-loading guns, and of the great inconvenience arising from the use of the shifting vent-piece when applied to heavy guns, the Committee have to report that, in an experiment made for the purpose of testing the relative inconvenience caused by the smoke of muzzle and breech-loading guns when fired from casemates, very great delays were experienced in loading a 7-inch breech-loading gun in consequence of the jamming of the vent-piece, notwithstanding the employment of the lever which has been supplied for overcoming this evil.

Throughout the experiments a tin cup was always used with Sir W. Armstrong's breech-loading wedge gun to prevent the escape of gas. All the projectiles were coated with lead.

The 70-pounder guns delivered by Mr. Whitworth were formed throughout of homogeneous metal or steel in successive thicknesses, forced over one another by hydraulic pressure. The vent in the first place had been made in the rear, but subsequently, as explained in the case of the 12-pounder, a vent was bored on the upper side of the gun in the usual manner. The practice was commenced by firing from the upper vent, but as it was observed after 1,025 rounds, that the upper surface of the bore of the gun exhibited signs of wear, Mr. Whitworth requested that the practice might be carried on from the vent, which he had originally made in the line of the axis of the piece through the breech. As Mr. Whitworth's original proposition for venting his gun had only been departed from by him in consequence of the Commandant at Shoeburyness having stated that an accident had occurred by a tube glancing from the unprotected breech loop, and as in the meanwhile this risk had been entirely obviated by the introduction of a cup to catch the tubes, the Committee assented to Mr. Whitworth's request. As, however, the Committee considered it necessary that Mr. Whitworth should adhere in the trial of his system to one mode of venting his 70-pounder guns, all the

practice which had been made from the upper vent was repeated from the rear vent, and the trials for endurance were transferred to another gun in which the rear vent was used exclusively. When firing from this vent, a peculiar construction of cartridge was found necessary in order to obtain the same range as from the top vent; in this cartridge a hollow tube of leather paper was inserted, extending from the rear of the cartridge to its centre, having a piece of quick match in it, so that the explosion should take place by ignition in the centre of the charge. The projectiles were all of hard metal, iron or steel, formed to fit the bore mechanically.

The muzzle-loading Armstrong 70-pounder shunt guns had steel barrels with super-imposed coils of wrought-iron shrunk on. There were three grooves in each gun on the shunt principle, to which rows of copper studs on the projectiles corresponded. The vent was in the upper side. All the projectiles fired both from Sir W. Armstrong's breech and muzzle loading guns for comparison with the solid shot fired from Mr. Whitworth's guns, with the exception of a few that were fired against iron plates, were not strictly speaking solid shot, but consisted of thick cylinders cast on cores with hollow conoidal heads.

As in the case of the 12-pounders the projectiles and fuzes were all supplied by the competitors, with the exception of the fuzes fired from Mr. Whitworth's guns and the fittings of the shrapnel shells, these were supplied by Colonel Boxer, R.A.

Lubrication was invariably used with all the guns unless specially stated to the contrary.

The cartridges and lubricators were all supplied from the Royal Laboratory, and to eliminate as far as possible all errors due to differences of powder, the cartridges were prepared from the same lots and brands.

The Committee took every precaution, as in the case of the 12-pounders, that the guns should be tried under like conditions, and allowed the competitors to have free access daily to the records of practice, inviting them to communicate with them on any points on which they were not satisfied.

The Committee now proceed to report the experiments made by them with the 70-pounders and the comparative qualities of the different guns and ammunition as deduced therefrom, under the various heads and in the order laid down in their instructions.

### I.—RANGE.

The guns were placed under exactly similar conditions and a number of rounds fired commencing with shot at 0° of elevation, common shell at 1° and segment or shrapnel shell at 2° of elevation, with shot again at 3°, common shell at 4°, segment or shrapnel shell at 5° of elevation, and so on, repeating the succession up to 12° of elevation. Some rounds of shot were also fired at 15° and 21° of elevation, common shell at 17°, and segment or shrapnel shell at 19°. The elevation in all cases was given by spirit level, and the position of each projectile as it fell on the sands was noted, full details of each day's practice being given in the Appendix.

From the practice so recorded the competitors were allowed to eliminate a proportion (as near 10 per cent. as possible) of the most unfavourable rounds; the general results of the remaining rounds are tabulated in the following abstracts.

#### SHOT.

| No. of Rounds. | Elevation. | Range in Yards of<br>Armstrong B. L. 70-pounder.<br>Projectile, hollow-headed Shot 70 lbs.<br>Charge of Powder - 9 „ |      |       |                      | Range in Yards of<br>Whitworth M. L. 70-pounder.<br>Projectile, solid Shot - 70.1 lbs.<br>Charge of Powder - 10 lbs. |      |       |                      | Range in Yards of<br>Armstrong M. L. 70-pounder.<br>Projectile, hollow-headed Shot 70 lbs.<br>Charge of Powder - 10 lbs. |      |       |                      |
|----------------|------------|----------------------------------------------------------------------------------------------------------------------|------|-------|----------------------|----------------------------------------------------------------------------------------------------------------------|------|-------|----------------------|--------------------------------------------------------------------------------------------------------------------------|------|-------|----------------------|
|                |            | Max.                                                                                                                 | Min. | Mean. | Mean error in range. | Max.                                                                                                                 | Min. | Mean. | Mean error in range. | Max.                                                                                                                     | Min. | Mean. | Mean error in range. |
| 20             | 0          | 478                                                                                                                  | 413  | 450   | Yds. 13.0            | 540                                                                                                                  | 476  | 506   | Yds. 17.1            | 504                                                                                                                      | 461  | 484   | Yds. 10.8            |
| 30             | 3          | 1430                                                                                                                 | 1329 | 1372  | 20.1                 | 1844                                                                                                                 | 1694 | 1761  | 29.2                 | 1664                                                                                                                     | 1581 | 1614  | 18.1                 |
| 40             | 6          | 2374                                                                                                                 | 2134 | 2266  | 43.1                 | 3008                                                                                                                 | 2835 | 2948  | 25.6                 | 2740                                                                                                                     | 2600 | 2656  | 25.5                 |
| 25             | 9          | 3220                                                                                                                 | 3055 | 3132  | 37.4                 | 4137                                                                                                                 | 3948 | 4051  | 48.4                 | 3618                                                                                                                     | 3451 | 3546  | 37.3                 |
| 20             | 12         | 4209                                                                                                                 | 3933 | 4119  | 59.2                 | 5388                                                                                                                 | 5240 | 5325  | 26.7                 | 4698                                                                                                                     | 4407 | 4559  | 53.1                 |
| 21             | 15         | 4844                                                                                                                 | 4621 | 4728  | 45.3                 | 6300                                                                                                                 | 6200 | 6252  | 24.0                 | 5422                                                                                                                     | 5126 | 5291  | 64.5                 |
| 18             | 21         | 6032                                                                                                                 | 5485 | 5821  | 123.3                | 8078                                                                                                                 | 7844 | 7965  | 65.8                 | 6528                                                                                                                     | 6100 | 6330  | 116.2                |
| *20            | 3          | —                                                                                                                    | —    | —     | —                    | 1742                                                                                                                 | 1504 | 1669  | 55.5                 | 1714                                                                                                                     | 1553 | 1640  | 36.8                 |
| *20            | 6          | —                                                                                                                    | —    | —     | —                    | 3165                                                                                                                 | 2770 | 3094  | 40.2                 | 2773                                                                                                                     | 2517 | 2655  | 56.2                 |
| †30            | 6          | 2386                                                                                                                 | 2262 | 2326  | 23.3                 | 2984                                                                                                                 | 2843 | 2922  | 35.4                 | 2730                                                                                                                     | 2602 | 2671  | 28.0                 |

\* Without Lubricators.

† After having fired 3000 rounds.



From this Table the relative range of the various guns with shot may be stated as follows:—

| ELEVATION. | WHITWORTH.                                                                                                                                                                           | M. L. ARMSTRONG.                                                                         |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| 0°         | 12 per cent. superior to the B. L. Armstrong.<br>Corresponding to 11' elevation.<br>5 per cent. superior to the M. L. Armstrong.<br>Corresponding to 3' elevation.                   | 7 per cent. superior to the B. L. Armstrong.<br>Corresponding to 6' elevation.           |
| 3°         | 28 per cent. superior to the B. L. Armstrong.<br>Corresponding to 1° 17' elevation.<br>9 per cent. superior to the M. L. Armstrong.<br>Corresponding to 24' elevation.               | 17 per cent. superior to the B. L. Armstrong.<br>Corresponding to 48' elevation.         |
| 6°         | 30 per cent. superior to the B. L. Armstrong.<br>Corresponding to 2° 19' elevation.<br>11 per cent. superior to the M. L. Armstrong.<br>Corresponding to 54' elevation.              | 17 per cent. superior to the B. L. Armstrong.<br>Corresponding to 1° 19' elevation.      |
| 9°         | 29 per cent. superior to the B. L. Armstrong.<br>Corresponding to 2° 58' elevation.<br>14 per cent. superior to the M. L. Armstrong.<br>Corresponding to 1° 35' elevation.           | 13 per cent. superior to the B. L. Armstrong.<br>Corresponding to 1° 20' elevation.      |
| 12°        | 29 per cent. superior to the B. L. Armstrong.<br>Corresponding to 4° 18' elevation.<br>17 per cent. superior to the M. L. Armstrong.<br>Corresponding to 3° elevation.               | 10 per cent. superior to the B. L. Armstrong.<br>Corresponding to 1° 30' elevation.      |
| 21°        | 37 per cent. superior to the B. L. Armstrong.<br>Corresponding to about 15° elevation.<br>26 per cent. superior to the M. L. Armstrong.<br>Corresponding to about 10° 15' elevation. | 9 per cent. superior to the B. L. Armstrong.<br>Corresponding to about 2° 50' elevation. |

It appears from the Table that the sums of the ratios of the mean errors in the ranges of the respective guns, when shot were fired, were as follows:—

|                          |   |       |
|--------------------------|---|-------|
| Breech-loading Armstrong | - | 12·02 |
| Whitworth                | - | 10·00 |
| Muzzle-loading Armstrong | - | 11·72 |

A comparison of these figures shows that the Whitworth gun with shot, is rather more uniform in range than the muzzle-loading Armstrong, and both are more uniform than the breech-loading Armstrong gun.

## COMMON SHELL.

| No. of Rounds. | Elevation. | Range in Yards of<br>Armstrong B. L. 70-pounder.<br>Projectile, common Shell - 68·75 lbs.<br>Charge of Powder 9 lbs. |      |       |                      | Range in Yards of<br>Whitworth M. L. 70-pounder.<br>Projectile, common Shell - 67·5 lbs.<br>Charge of Powder 10 lbs. |      |       |                      | Range in Yards of<br>Armstrong M. L. 70-pounder.<br>Projectile, common Shell - 69·75 lbs.<br>Charge of Powder 10 lbs. |      |       |                      |
|----------------|------------|----------------------------------------------------------------------------------------------------------------------|------|-------|----------------------|----------------------------------------------------------------------------------------------------------------------|------|-------|----------------------|-----------------------------------------------------------------------------------------------------------------------|------|-------|----------------------|
|                |            | Max.                                                                                                                 | Min. | Mean. | Mean error in range. | Max.                                                                                                                 | Min. | Mean. | Mean error in range. | Max.                                                                                                                  | Min. | Mean. | Mean error in range. |
| 30             | 0          | 754                                                                                                                  | 678  | 715   | Yds.<br>17·5         | 938                                                                                                                  | 842  | 883   | Yds.<br>23·3         | 855                                                                                                                   | 799  | 828   | Yds.<br>12·6         |
| 30             | 4          | 1596                                                                                                                 | 1496 | 1548  | 24·2                 | 2073                                                                                                                 | 1915 | 1987  | 29·8                 | 1843                                                                                                                  | 1729 | 1806  | 27·3                 |
| 34             | 7          | 2704                                                                                                                 | 2472 | 2579  | 45·5                 | 3398                                                                                                                 | 3274 | 3340  | 29·5                 | 3166                                                                                                                  | 2915 | 3025  | 74·3                 |
| 28             | 10         | 3432                                                                                                                 | 3212 | 3345  | 46·4                 | 4356                                                                                                                 | 4055 | 4221  | 45·7                 | 3880                                                                                                                  | 3698 | 3789  | 39·3                 |
| 18             | 17         | 5114                                                                                                                 | 4868 | 5040  | 40·2                 | 6797                                                                                                                 | 6683 | 6740  | 31·7                 | 5629                                                                                                                  | 5455 | 5550  | 46·9                 |

From this Table the relative range of the various guns with common shell may be stated as follows:—

| ELEVATION. | WHITWORTH.                                                                                                                                                                         | M. L. ARMSTRONG.                                                                      |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1°         | 23 per cent. superior to the B. L. Armstrong.<br>Corresponding to 32' elevation.<br>6 per cent. superior to the M. L. Armstrong.<br>Corresponding to 9' elevation.                 | 15 per cent. superior to the B. L. Armstrong.<br>Corresponding to 21' elevation.      |
| 4°         | 28 per cent. superior to the B. L. Armstrong.<br>Corresponding to 1° 24' elevation.<br>10 per cent. superior to the M. L. Armstrong.<br>Corresponding to 33' elevation.            | 16 per cent. superior to the B. L. Armstrong.<br>Corresponding to 49' elevation.      |
| 7°         | 29 per cent. superior to the B. L. Armstrong.<br>Corresponding to 3° elevation.<br>10 per cent. superior to the M. L. Armstrong.<br>Corresponding to 55' elevation.                | 17 per cent. superior to the B. L. Armstrong.<br>Corresponding to 1° 30' elevation.   |
| 17°        | 33 per cent. superior to the B. L. Armstrong.<br>Corresponding to about 7° elevation.<br>21 per cent. superior to the M. L. Armstrong.<br>Corresponding to about 4° 45' elevation. | 10 per cent. superior to the B. L. Armstrong.<br>Corresponding to about 2° elevation. |

From the above Table it appears that the sums of the ratios of the mean errors of the respective guns, when common shell were fired, are as follows:—

|                          |   |      |
|--------------------------|---|------|
| Breech-loading Armstrong | - | 6·37 |
| Whitworth                | - | 6·24 |
| Muzzle-loading Armstrong | - | 7·13 |

A comparison of these figures would show that with common shell, the Whitworth gun is somewhat more uniform in range than the breech-loading Armstrong, and both rather more so than the muzzle-loading Armstrong gun.

SEGMENT AND SHRAPNEL SHELL.

| No. of Rounds. | Elevation. | Range in Yards of<br>Armstrong B. L. 70-pounder.<br>Projectile, segment Shell - 77·6 lbs.<br>Charge of Powder - 9 lbs. |      |       |                      | Range in Yards of<br>Whitworth M. L. 70-pounder.<br>Projectile, Shrapnel Shell 67·7 lbs.<br>Charge of Powder - 10 lbs. |      |       |                      | Range in Yards of<br>Armstrong M. L. 70-pounder.<br>Projectile, segment Shell - 68·9 lbs.<br>Charge of Powder - 10 lbs. |      |       |                      |
|----------------|------------|------------------------------------------------------------------------------------------------------------------------|------|-------|----------------------|------------------------------------------------------------------------------------------------------------------------|------|-------|----------------------|-------------------------------------------------------------------------------------------------------------------------|------|-------|----------------------|
|                |            | Max.                                                                                                                   | Min. | Mean. | Mean error in range. | Max.                                                                                                                   | Min. | Mean. | Mean error in range. | Max.                                                                                                                    | Min. | Mean. | Mean error in range. |
|                |            |                                                                                                                        |      |       | Yds.                 |                                                                                                                        |      |       | Yds.                 |                                                                                                                         |      |       | Yds.                 |
| 30             | 2°         | 1050                                                                                                                   | 978  | 1012  | 16·5                 | 1410                                                                                                                   | 1293 | 1355  | 29·1                 | 1314                                                                                                                    | 1200 | 1263  | 27·4                 |
| 16             | 5          | 2006                                                                                                                   | 1882 | 1938  | 28·4                 | 2610                                                                                                                   | 2515 | 2557  | 20·9                 | 2334                                                                                                                    | 2256 | 2304  | 18·7                 |
| 20             | 8          | 2942                                                                                                                   | 2703 | 2808  | 39·4                 | 3811                                                                                                                   | 3712 | 3753  | 24·2                 | 3475                                                                                                                    | 3306 | 3397  | 32·3                 |
| 35             | 11         | 3589                                                                                                                   | 3310 | 3477  | 54·2                 | 4791                                                                                                                   | 4539 | 4649  | 45·0                 | 4160                                                                                                                    | 4000 | 4072  | 42·7                 |
| 15             | 19         | 5490                                                                                                                   | 5250 | 5363  | 71·2                 | 7818                                                                                                                   | 7612 | 7712  | 63·2                 | 6802                                                                                                                    | 6407 | 6603  | 104·8                |

From this Table the relative range of the various guns with segment and shrapnel shell may be stated as follows:—

| ELEVATION. | WHITWORTH.                                                                                                                                                                          | M. L. ARMSTRONG.                                                                          |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| 2°         | 34 per cent. superior to the B. L. Armstrong.<br>Corresponding to 1° 6' elevation.<br>7 per cent. superior to the M. L. Armstrong.<br>Corresponding to 16' elevation.               | 24 per cent. superior to the B. L. Armstrong.<br>Corresponding to 48' elevation.          |
| 5°         | 32 per cent. superior to the B. L. Armstrong.<br>Corresponding to 2° 4' elevation.<br>11 per cent. superior to the M. L. Armstrong,<br>Corresponding to 42' elevation.              | 19 per cent. superior to the B. L. Armstrong.<br>Corresponding to 1° 13' elevation.       |
| 8°         | 34 per cent. superior to the B. L. Armstrong.<br>Corresponding to 3° 41' elevation.<br>10 per cent. superior to the M. L. Armstrong.<br>Corresponding to 1° 12' elevation.          | 21 per cent. superior to the B. L. Armstrong.<br>Corresponding to 2° 18' elevation.       |
| 19°        | 43 per cent. superior to the B. L. Armstrong.<br>Corresponding to about 10° elevation.<br>17 per cent. superior to the M. L. Armstrong.<br>Corresponding to about 4° 10' elevation. | 23 per cent. superior to the B. L. Armstrong.<br>Corresponding to about 5° 15' elevation. |

The sums of the ratios of the mean errors in the ranges of the respective guns when segment or shrapnel shell were fired, as given by the preceding Table, are:—

|                          |   |      |
|--------------------------|---|------|
| Breech-loading Armstrong | - | 6·52 |
| Whitworth                | - | 5·92 |
| Muzzle-loading Armstrong | - | 6·65 |

From these figures it would appear that with these particular projectiles, the uniformity in the range of each gun is nearly equal, being very slightly in favour of the Whitworth gun.

The ranges obtained with special charges and projectiles will be considered hereafter.

## II.—INITIAL VELOCITY AND RETARDATION.

A series of experiments to determine the initial velocity and retardation of the various projectiles fired from the 70-pounder guns was carried on for the Committee by Lieut. Noble, R.A. with the electro-ballistic apparatus invented by Major Navez, of the Belgian artillery.

These experiments were not only made with the proposed ordinary charges of 9 lbs. of powder for the breech-loading Armstrong gun and of 10 lbs. for each of the muzzle-



loading guns, but were extended with a view to ascertaining the velocities of shot and common shell when fired with the larger charges of powder, which the competitors considered might be used with their muzzle-loading guns on occasions when high velocities might be required for the purpose of obtaining greater penetration, as for instance when firing against armour-plated ships.

Two of Major Navez' instruments were employed, by means of which the velocity of each projectile was determined at two points in its flight, 40 and 500 yards distant from the muzzles of the guns.

The experiments, details of which are to be found in the Appendix, were continued until five good observations were obtained with each nature of projectile and each charge; the general results are summed up in the following Table.

## 70-POUNDERS.

| Nature of Gun. | Projectile. |         | Charge. | Observed Velocity at |          | Observed Loss of Velocity in | Calculated mean initial Velocity. |
|----------------|-------------|---------|---------|----------------------|----------|------------------------------|-----------------------------------|
|                | Nature.     | Weight. |         | 40 yds.              | 500 yds. | 460 yds.                     |                                   |

## Results with Ordinary Charges.

|                   |                    |       |    | ft. per sec. | ft. per sec. |       | ft. per sec. |
|-------------------|--------------------|-------|----|--------------|--------------|-------|--------------|
| B. L. Armstrong - | Hollow-headed shot | 70·81 | 9  | 1154·8       | 1068·2       | 86·6  | 1163         |
| Whitworth -       | Solid shot -       | 70·09 | 10 | 1329·5       | 1243·2       | 86·3  | 1338         |
| M. L. Armstrong - | Hollow-headed shot | 71·25 | 10 | 1325·2       | 1197·2       | 128·0 | 1336         |
| B. L. Armstrong - | Common shell -     | 69·80 | 9  | 1166·9       | 1080·9       | 86·0  | 1175         |
| Whitworth -       | " -                | 70·30 | 10 | 1332·7       | 1244·4       | 88·3  | 1341         |
| M. L. Armstrong - | " -                | 70·30 | 10 | 1323·8       | 1206·5       | 117·3 | 1334         |
| B. L. Armstrong - | Segment shell -    | 76·64 | 9  | 1091·5       | 1015·3       | 76·2  | 1098         |
| Whitworth -       | Shrapnel shell -   | 67·84 | 10 | 1370·9       | 1274·9       | 96·0  | 1380         |
| M. L. Armstrong - | Segment shell -    | 69·20 | 10 | 1349·0       | 1227·5       | 121·5 | 1360         |

## Results with Special Charges.

|                   |                    |       |    | ft. per sec. | ft. per sec. |       | ft. per sec. |
|-------------------|--------------------|-------|----|--------------|--------------|-------|--------------|
| Whitworth -       | Solid shot -       | 70·09 | 12 | 1386·1       | 1292·4       | 93·7  | 1395         |
| M. L. Armstrong - | Hollow-headed shot | 71·25 | 12 | 1486·6       | 1336·93      | 149·7 | 1500         |
| Whitworth -       | Common shell -     | 70·30 | 12 | 1375·0       | 1283·0       | 92·0  | 1384         |
| " -               | Shrapnel shell -   | 67·84 | 12 | 1417·4       | 1315·4       | 102·0 | 1427         |
| M. L. Armstrong - | Segment shell -    | 69·20 | 12 | 1496·7       | 1346·4       | 150·3 | 1510         |
| " -               | Hollow-headed shot | 71·25 | 14 | 1524·8       | 1367·4       | 157·4 | 1539         |
| " -               | Segment shell -    | 69·20 | 14 | 1576·1       | 1416·1       | 160·0 | 1591         |

From these experiments it appears that the initial velocities of the ordinary projectiles fired with the proposed service charges of powder from the muzzle-loading Armstrong and Whitworth guns are about equal, and that they are from 160 to 170 feet per second greater than those of the shot or common shell, and 270 feet per second greater than those of the segment shells fired from the breech-loading Armstrong gun.

By increasing the charge of the Whitworth gun from 10 to 12 lbs. of powder the initial velocity was increased—

With solid shot from 1,338 to 1,395 or 57 ft. per second.

With common shell from 1,341 to 1,384 or 43 ft. per second.

With shrapnel shell from 1,380 to 1,427 or 47 ft. per second.

By increasing the charge of the muzzle-loading Armstrong gun from 10 to 12 lbs. the initial velocity was increased—

With shot from 1,336 to 1,500 or 164 ft. per second.

With segment shell from 1,360 to 1,510 or 150 ft. per second.

And by increasing the charge of the same gun still further to 14 lbs. of powder the initial velocities as compared with those obtained with charges of 10 lbs. was increased—

With shot from 1,336 to 1,539 or 203 ft. per second.

With segment shell from 1,360 to 1,591 or 231 ft. per second.

These experiments prove that the retardation of the respective Whitworth projectiles is nearly equal; the shrapnel shell however suffers rather the most. Similarly the retardation of the respective projectiles of the Armstrong guns is nearly equal, that of the common shells being rather the least.

The retardation however of the Whitworth projectiles is very considerably less than that of any of the projectiles fired from either of the Armstrong guns with equal velocities, thus fully corroborating the results deduced under the head of range.

It further appears from these experiments, that as the initial velocities of the projectiles

fired from the Whitworth gun are not materially increased by the augmentation of the charge from 10 to 12 lbs. of powder, the calibre of the gun is such, that when fired with the proposed service charge of 10 lbs., for which it is calculated, it produces nearly a maximum effect, and that any material addition to that charge only causes a useless consumption of powder. The higher initial velocities obtained from the muzzle-loading Armstrong gun with charges of 12 and 14 lbs. prove, on the contrary, that this gun is well able to consume those increased charges, which, as will be seen by experiments to be hereafter detailed, augmented the range of this gun to a very considerable extent with apparently much greater accuracy as compared with the results obtained with the proposed service charge of 10 lbs. of powder.

### III.—ACCURACY.

The guns were tested for accuracy by the same series of experiments by which their range was determined. The Appendix contains the detailed records of this practice, showing the position in which each projectile fell upon the sands. From these details, after elimination by the competitors of a small proportion (about 10 per cent. of the rounds), the mean ranges and mean radial distances, as shown in the following Tables, have been calculated in the same manner as was done when the 12-pounders were under consideration, and as is explained at p. xxii. of the preliminary report of the Committee.

In these experiments practice was carried on with shot at elevations of 0°, 3°, 6°, 9°, 12°, and 15°; with common shell at 1°, 4°, 7°, and 10°, and with segment or shrapnel shell at 2°, 5°, 8°, and 11°.

In consequence of the comparative practice with each description of projectile having been made at elevations varying from each other to the extent of 3°, and of the great difference in range of the guns when fired at the same elevation, it has been impossible to select equal ranges for the purpose of comparing the radial distances which indicate the relative accuracy of the guns with each nature of projectile. The Committee have therefore compared the results at the ranges which most nearly approximate, and have also drawn up the accompanying diagrams to illustrate the relative range and accuracy for each description of projectile when fired with the proposed service charge.

These diagrams are constructed by laying down on the horizontal line the mean ranges, setting off the mean radial distances at right angles to them, and then connecting the points thus obtained.

The Committee would here remark that they do not consider the lines in the diagrams joining the various points which indicate the accuracy obtained at any particular elevation as showing correctly the accuracy of the gun at intermediate ranges (which they would do if they formed portions of a curve drawn from sufficient data), but they do consider that these diagrams are of value, inasmuch as when combined with the tables of comparative accuracy they assist in guiding the judgment, and also exhibit very clearly to the eye the character of the shooting of the different guns.

#### SHOT.

| Elevation. | No. of Rounds. | 70-Pr. ARMSTRONG B. L.<br>Charge 9 lbs. |                  | 70-Pr. WHITWORTH.<br>Charge 10 lbs. |                  | 70-Pr. ARMSTRONG M. L.<br>Charge 10 lbs. |                  |
|------------|----------------|-----------------------------------------|------------------|-------------------------------------|------------------|------------------------------------------|------------------|
|            |                | Mean Range.                             | Radial Distance. | Range.                              | Radial Distance. | Range.                                   | Radial Distance. |
| °          |                | yards.                                  | inches.          | yards.                              | inches.          | yards.                                   | inches.          |
| 0          | 20             | 450                                     | 20               | 506                                 | 21               | 484                                      | 14               |
| 3          | 30             | 1372                                    | 63               | 1761                                | 96               | 1614                                     | 68               |
| 6          | 40             | 2266                                    | 230              | 2948                                | 156              | 2656                                     | 159              |
| 9          | 25             | 3132                                    | 267              | 4051                                | 371              | 3546                                     | 295              |
| 12         | 20             | 4119                                    | 598              | 5325                                | 297              | 4559                                     | 534              |
| 15         | 21             | 4728                                    | 702              | 6252                                | 402              | 5291                                     | 907              |
| * {        | 11             | 4595                                    | 982              | 5963                                | 450              | 5086                                     | 370              |
|            | 7              | 4927                                    | 510              | 6323                                | 813              | 5357                                     | 457              |
| † 3        | 20             | —                                       | —                | 1669                                | 143              | 1640                                     | 124              |
| † 6        | 20             | —                                       | —                | 3094                                | 211              | 2655                                     | 292              |
| † 6        | 30             | 2326                                    | 161              | 2922                                | 211              | 2671                                     | 187              |

\* The elevation at which these rounds were fired is doubtful.

† Without lubricators.

‡ After firing 3,000 rounds.



TABLE OF RELATIVE ACCURACY.

| Ranges. |       |       | Ratios of Accuracy at the specified Ranges. |       |       |
|---------|-------|-------|---------------------------------------------|-------|-------|
| B. L.   | Whit. | M. L. | B. L.                                       | Whit. | M. L. |
| 450     | 506   | 484   | 1·5                                         | 1·5   | 1·0   |
| —       | 1761  | 1614  | —                                           | 1·4   | 1·0   |
| —       | 1669  | 1640  | —                                           | 1·1   | 1·0   |
| 3132    | 2922  | 2671  | 1·4                                         | 1·1   | 1·0   |
| 3132    | 2948  | 2656  | 1·6                                         | 1·0   | 1·0   |
| —       | 3094  | 2655  | —                                           | 1·0   | 1·4   |
| 4119    | 4051  | 3546  | 2·0                                         | 1·2   | 1·0   |
| 4119    | 4051  | 4559  | 1·6                                         | 1·0   | 1·4   |
| —       | 5325  | 5357  | —                                           | 1·0   | 1·5   |

It thus appears—

1st. That up to a range of about 1,700 yards the accuracy of the muzzle-loading Armstrong is superior to that of the other two guns, and that the accuracy of the breech-loading Armstrong and the Whitworth guns may be considered as about equal.

2nd. That at a range of about 3,500 yards the accuracy of the muzzle-loading guns may be considered as about equal, also that the accuracy of the breech-loading Armstrong is decidedly inferior to that of both the muzzle-loading guns.

3rd. That at ranges greater than about 3,500 yards, the Whitworth gun exhibits a decided superiority over the muzzle-loading Armstrong gun, and this latter a very marked superiority over the breech-loading Armstrong.

It further appears from the table of ranges, combined with an inspection of the probable rectangles, that the Whitworth gun made good practice up to a range of 8,000 yards, which is about 2,000 yards in excess of the ranges attained by either of the Armstrong guns at the same elevation of 21°.

COMMON SHELL (SHORT).

| Elevation. | No. of Rounds. | 70-PR. ARMSTRONG B. L.<br>Charge 9 lbs. |                  | 70-PR. WHITWORTH.<br>Charge 10 lbs. |                  | 70-PR. ARMSTRONG M. L.<br>Charge 10 lbs. |                  |
|------------|----------------|-----------------------------------------|------------------|-------------------------------------|------------------|------------------------------------------|------------------|
|            |                | Mean Range.                             | Radial Distance. | Range.                              | Radial Distance. | Range.                                   | Radial Distance. |
|            |                | yards.                                  | inches.          | yards.                              | inches.          | yards.                                   | inches.          |
| 1          | 30             | 715                                     | 29               | 882                                 | 44               | 828                                      | 25               |
| 4          | 30             | 1548                                    | 90               | 1987                                | 101              | 1805                                     | 89               |
| 7          | 34             | 2579                                    | 251              | 3340                                | 203              | 3025                                     | 430              |
| 10         | 28             | 3345                                    | 388              | 4221                                | 439              | 3789                                     | 375              |

TABLE OF RELATIVE ACCURACY.

| Ranges. |       |       | Ratios of Accuracy at the specified Ranges. |       |       |
|---------|-------|-------|---------------------------------------------|-------|-------|
| B. L.   | Whit. | M. L. | B. L.                                       | Whit. | M. L. |
| 715     | 882   | 828   | 1·2                                         | 1·4   | 1·0   |
| 1548    | 1987  | 1805  | 1·0                                         | 1·1   | 1·0   |
| 3345    | 3340  | 3025  | 1·9                                         | 1·0   | 2·1   |
| —       | 4221  | 3789  | —                                           | 1·2   | 1·0   |

It thus appears—

1st. That up to a range of about 1,700 yards the accuracy of the muzzle-loading Armstrong may be considered as superior to that of the other two guns, and that the accuracy of the breech-loading Armstrong and the Whitworth may be considered as equal.

2nd. That up to a range of about 3,500 yards the accuracy of the Armstrong guns may be considered as equal, and that at this high range the Whitworth exhibits a superiority sufficiently marked over the Armstrong guns.

An inspection of the probable rectangles also shows that with short common shells the three guns make good practice at  $17^{\circ}$  of elevation, that with the Whitworth being the best, and at considerably the greatest range, viz., at 6,740 yards, as compared with that of the breech-loader at 5,040 yards, and of the muzzle-loader at 5,550 yards.

## SEGMENT AND SHRAPNEL SHELL.

| Elevation. | No. of Rounds. | 70-Pr. ARMSTRONG B. L.<br>Charge 9 lbs. |                  | 70-Pr. WHITWORTH.<br>Charge 10 lbs. |                  | 70-Pr. ARMSTRONG M. L.<br>Charge 10 lbs. |                  |
|------------|----------------|-----------------------------------------|------------------|-------------------------------------|------------------|------------------------------------------|------------------|
|            |                | Mean Range.                             | Radial Distance. | Range.                              | Radial Distance. | Range.                                   | Radial Distance. |
|            |                | yards.                                  | inches.          | yards.                              | inches.          | yards.                                   | inches.          |
| 2          | 30             | 1012                                    | 38               | 1355                                | 80               | 1264                                     | 78               |
| 5          | 16             | 1938                                    | 130              | 2557                                | 99               | 2304                                     | 86               |
| 8          | 20             | 2808                                    | 278              | 3753                                | 205              | 3397                                     | 248              |
| 11         | 35             | 3477                                    | 555              | 4649                                | 458              | 4072                                     | 495              |

TABLE OF RELATIVE ACCURACY.

| Ranges. |       |       | Ratios of Accuracy at the specified Ranges. |       |       |
|---------|-------|-------|---------------------------------------------|-------|-------|
| B. L.   | Whit. | M. L. | B. L.                                       | Whit. | M. L. |
| 1012    | 1355  | 1264  | 1.0                                         | 2.1   | 2.0   |
| 2808    | 2557  | 2304  | 3.2                                         | 1.2   | 1.0   |
| 3477    | 3753  | 3397  | 2.7                                         | 1.0   | 1.2   |
| —       | 3753  | 4072  | —                                           | 1.0   | 2.4   |

It thus appears—

1st. That up to a range of about 1,600 yards the breech-loading exhibits a decided superiority over the muzzle-loading guns, which, however, it soon loses, as at 1,900 yards and all higher ranges it is far inferior to them both.

2nd. That at ranges of about 3,000 yards the accuracy of the muzzle-loading guns may be considered as about equal.

3rd. That at greater ranges than about 3,000 yards the Whitworth gun exhibits a marked superiority over the muzzle-loading Armstrong gun.

It is further apparent from the inspection of the probable rectangles, that with segment and shrapnel shell the breech-loading Armstrong and the Whitworth guns made good practice at  $19^{\circ}$  of elevation, at the respective ranges of 5,368 and 7,778 yards, the Whitworth, however, making the better of the two; also that at this elevation the muzzle-loading Armstrong gun made but indifferent practice at 6,605 yards as compared with the other two guns.

As shot, common shell, and segment or shrapnel shell, are liable to be fired indifferently from all siege, garrison, or naval guns, the Committee consider it desirable to combine the results obtained with these projectiles, and to state the probable relative accuracy of the three guns, irrespective of the projectile, when fired with the proposed service charges, and having thoroughly weighed the subject, they are of opinion that the relative accuracy of the three guns may be stated as follows:—

1st. Up to a range of about 1,500 yards the accuracy of the breech-loading Armstrong and the Whitworth guns may be considered as equal, and that up to this range the accuracy of the muzzle-loading Armstrong gun is superior to both.

2nd. At greater ranges than 1,500 yards the accuracy of the breech-loading Armstrong gun is inferior to that of both the muzzle-loading guns, and this inferiority increases with the range, and is very marked at all ranges beyond 2,500 yards; also that at ranges from 1,500 to between 3,000 and 3,500 yards the accuracy of the muzzle-loading guns is equal.

3rd. At higher ranges than 3,500 yards the Whitworth gun may be considered as possessing an accuracy decidedly superior to that of the muzzle-loading Armstrong gun.

Although undoubtedly lubrication is advantageous as tending both to lessen the wear caused by the friction of the projectile in passing down the bore, and also to promote the accuracy of the fire of the guns, circumstances might arise on service when guns would have to be fired without lubrication. The Committee therefore caused a



number of rounds to be fired with the two muzzle-loading guns without lubricators, for the purpose of ascertaining the effect which would be produced upon their fire. The result showed that their ranges were very little affected, but that there was a considerable loss in accuracy with both guns, and that this loss was rather greater with the muzzle-loading Armstrong than with the Whitworth gun.

As it had been ascertained, from other experiments, that the lead coating strips from the projectiles when fired from the breech-loading Armstrong gun without lubrication, causing great uncertainty in their flight, the Committee did not consider it necessary to test this gun in a similar manner.

The results of this practice with the two muzzle-loading guns are shown in the preceding table and first diagram, in which the relative accuracy of the guns when fired without lubricators is indicated by a coloured dot with an asterisk, and the elevation at which the gun was fired marked against them.

#### IV.—PENETRATION.

The powers of penetration of the various guns were tested by firing shot and common shell against brickwork and against iron plates.

The Committee applied to the Secretary of State for War for the necessary means for trying the relative effects of the various projectiles when fired against earthworks, but were unable to carry on any experiments, as there was no earthwork available in which shells could be burst with safety.

The brickwork fired at was a martello tower for one gun, which had been built in 1804 at Bexhill, on the coast of Sussex; the total height of the tower was 31·5 feet, the diameter at the base was 46 feet, and that of the top 40 feet. The platform upon which the gun was intended to be mounted was carried by a semicircular arch turned from a pillar in the centre of the tower, 4 feet in diameter, to the exterior wall, there being about 5 feet in thickness of brickwork between the crown of the arch and the platform of the battery above it.

Towers of this construction were the only objects available for testing the relative powers of penetration of the projectiles fired from the various guns, being the only brickwork of sufficient dimensions in the possession of the War Department, to the destruction of which there was no objection. A martello tower is not, however, an object which, from its construction, is well calculated for the comparative experiments the Committee were desirous of making.

The situation of the tower with reference to adjoining property was such, that conditions of safety precluded the Committee from firing at it from any direction but one. All three guns had therefore to be in one battery, which was 750 yards distant from the tower, and as a consequence the portions of the tower allotted to each gun as a target were somewhat different, and as the brickwork varied in thickness at almost every foot of its height, the difficulty of obtaining good results for comparison was very much enhanced. The object of the Committee not being to destroy the tower, but to obtain good relative penetration for comparison, the firing was commenced with common shell filled with sand.

It appeared that these shells fired from both of the muzzle-loaders had sufficient power to pass through the brickwork where it was 7 feet thick, the muzzle-loading Armstrong shell being found unbroken inside, and the Whitworth shell in pieces; the shell from the breech-loader penetrated 4·75 feet into the wall where it was 7·25 thick, and 5·6 feet into the wall where it was about 6·4 feet thick, cracking the brickwork inside and knocking away three bricks of one course.

A shot from each gun struck on the solid part of the tower where the brickwork is about 40 feet thick; the hollow-headed shot of the breech-loading Armstrong gun penetrated 3 feet; the solid shot from the Whitworth gun passed through 7·25 feet of brickwork, having deflected downwards and broken through the crown of the arch; the hollow-headed shot from the muzzle-loading Armstrong gun penetrated 4·75 feet. All the measurements of penetration where the projectiles did not pass through the wall were taken to their bases.

Only one live shell was fired from each gun with results which were capable of comparison, after which the tower became so injured that the amount of damage attributable to each round could not be recorded.

So far as could be judged from the effect of these single live shells, that from the muzzle-loading Armstrong gun had a decided advantage; it burst in about the same relative position as the shell from the Whitworth gun, but, as might naturally have been

expected, its bursting charge of 4·5 lbs. of powder produced considerably greater destructive effect than the bursting charge of 2·65 lbs. in the Whitworth shell.

The shell from the breech-loading Armstrong gun produced more damage than that from the Whitworth on the outside of the wall, but little or no damage inside; it also produced less damage than the shell from the muzzle-loading Armstrong on the outside. As it carried a bursting charge of 4·75 lbs., which was somewhat greater than this latter shell, it would appear that the penetration was not sufficient to secure a good action of the bursting charge as a mine to destroy the wall. The wall was injured by the shell from the breech-loading gun to about the same extent as by that from the Whitworth gun.

### V.—EASE OF WORKING.

The ease with which the various guns were capable of being worked was constantly under the observation of the Committee throughout the long course of experiments they have conducted with the competitive 70-pounders, but in order to test the guns thoroughly in this respect they obtained permission to carry on a series of experiments on board H.M.S. "Excellent," under the superintendence of Captain Key, C.B., R.N.

In the first instance the guns were mounted as broadside guns on common truck carriages on the lower deck of the ship, and were tried by being fired 52 rounds of "independent firing" and 80 rounds of "quick firing."

This practice was carried on in series of 20 rounds fired from each gun separately, the times being carefully noted. Two guns crews of 15 men each were employed to work the guns, relieving each other after each series of rounds. The guns were laid for the "independent firing" on a target at 2,600 yards, and were fired as rapidly as consistent with proper laying.

In the "quick firing" an elevation of from 5° to 7° was given on account of the danger attending ricochet in Portsmouth harbour, and the direction had to be brought on by handspikes.

In consequence of a delay in the arrival of the Whitworth cartridges, 40 rounds of "independent" and 40 rounds of "quick" firing were completed by the Armstrong guns before the Whitworth gun took up the firing.

This gave an advantage to the Whitworth gun, as the men advanced in smartness as the firing proceeded.

The following is an abstract of the practice, of which a full report is given in the Appendix.

| Nature of Gun.       | B. L. Armstrong. |           |                         | Whitworth.     |           |                         | M. L. Armstrong. |           |                         |
|----------------------|------------------|-----------|-------------------------|----------------|-----------|-------------------------|------------------|-----------|-------------------------|
|                      | No. of Rounds.   | Time.     | Average Time per Round. | No. of Rounds. | Time.     | Average Time per Round. | No. of Rounds.   | Time.     | Average Time per Round. |
| Independent firing - | 20               | min. sec. | sec.                    | 20             | min. sec. | sec.                    | 20               | min. sec. | sec.                    |
|                      | 20               | 15 0      | 47·6                    | 20             | 14 15     | 45·0                    | 20               | 18 41     | 59·0                    |
|                      | 20               | 10 23     | 32·8                    | 20             | 14 48     | 41·5                    | 20               | 16 28     | 52·0                    |
| Quick firing -       | 12               | 6 50      | 37·3                    | 12             | 9 55      | 54·1                    | 12               | 9 46      | 53·3                    |
|                      | 20               | 9 50      | 31·0                    | 20             | 11 50     | 37·3                    | 20               | 14 40     | 46·3                    |
|                      | 20               | 17 10     | 54·2                    | 18             | 9 48      | 36·4                    | 20               | 13 2      | 41·3                    |
|                      | 20               | 7 17      | 23·0                    | 20             | 10 42     | 33·8                    | 20               | 9 59      | 31·5                    |
|                      | 20*              | 8 13      | 26·0                    | 20*            | 12 56     | 40·8                    | 20*              | 9 55      | 31·3                    |

\* Without lubrication.

In these experiments the breech-loading gun showed great superiority in respect of ease of working, one series of 20 rounds having been completed in 7 minutes 17 seconds, or at the rate of one round in 23 seconds. The loading was performed with ease, and usually finished before the gun was run out in the port.

The muzzle-loading guns were more nearly on an equality in this respect, the shortest time of firing 20 rounds having been 10 minutes 42 seconds, or one round in 33·8 seconds, for the Whitworth gun, and for the muzzle-loading Armstrong gun 9 minutes 55 seconds, or one round in 31·3 seconds; this comparison has been made from practice in which the crews who worked the guns were equally experienced.

It was found, however, with the breech-loader, that after a considerable number of rounds (during the second series of quick firing) it was necessary to remove the deposit which had fallen in the ways, and checked the free action of the wedge and cupholder.



This was easily done by the application of a wet cloth. The smoke from the breech-loader was observed to hang rather more about the deck than that from the muzzle-loaders, which led to the inference that in a battery between decks composed entirely of breech-loading guns, the smoke from them, when fired with rapidity, and loaded whilst being run out, would cause more serious inconvenience than with the others.

The Whitworth gun was loaded with perfect ease, but the sponging with the bristle sponge was rather heavy. Mr. Whitworth's rear vent, however, was a constant source of delay and difficulty. From its position at the bottom of the bore and its construction protruding somewhat into the bore, it was liable to become closed by the blows given by the iron spindle of the sponge head in the operation of sponging, and the gun was not so easily primed as with the top vent. It also necessitated the employment of a more complicated cartridge, and rendered the gun liable to a greater accumulation of deposit in the chamber.

With the muzzle-loading Armstrong or shunt gun the loading was performed with perfect ease, the shot being rammed home hand over hand without a check; on two occasions only was there a slight delay caused by the studs on the shot having been entered in the shallow grooves.

As circumstances might arise on service when guns would have to be fired without lubrication, the Committee caused the guns to be tested with 20 rounds of rapid fire without lubrication; the muzzle-loading Armstrong gun exhibited a considerable superiority to the Whitworth in this trial. The result accords with that obtained in a similar trial with the 12-prs.

The recoil of all the guns, especially that of the breech-loader, was sharp, but not unmanageable; the guns being well balanced on their trunnions and in their carriages, were run out and pointed with great ease; but, as might naturally be expected from its being lighter, with somewhat greater ease in the case of the breech-loader than with the muzzle-loaders.

Previous to the above practice and before the rear vent of the Whitworth gun was used, 120 rounds were fired at Shoeburyness from each gun in series of 20 rounds each, the detachments being changed after each series. The Committee have here to remark that the upper or vertical vent has, as before mentioned, the advantage over that in the axis of the gun, inasmuch as the gun is more readily primed, and there is much less risk of the firing being delayed by the choking of the vent through accumulation of deposit.

The time occupied in firing these rounds was—

|                                      |   | Min.  | Sec.    |            |
|--------------------------------------|---|-------|---------|------------|
| For the breech-loading Armstrong gun | - | 88    | or 44   | per round. |
| For the Whitworth gun                | - | 127   | „ 63.5  | „          |
| For the muzzle-loading Armstrong gun | - | 132.5 | „ 66.25 | „          |

The shortest time occupied in firing 20 rounds was—

|                            |   |      |         |   |
|----------------------------|---|------|---------|---|
| For the B.L. Armstrong gun | - | 12.5 | or 37.5 | „ |
| For the Whitworth gun      | - | 16   | „ 48    | „ |
| For the M.L. Armstrong gun | - | 18.5 | „ 55.5  | „ |

During the last series of 20 rounds the wedge of the breech-loader worked stiffly, but at the conclusion of the experiment the application of a little water in the slot, caused it to work as freely as at the commencement.

The Whitworth gun was loaded with very great ease throughout.

At the 17th round with the muzzle-loading Armstrong gun the shot stuck, and was only driven home with very great difficulty, after which water was used throughout the remainder of the experiment. A sponge with spring scraper, the use of which was attended with great labour to the men, was passed down the bore after each round.

Judging, however, from later experiments, especially those carried out on board H.M.S. "Excellent," where the loading was performed with most perfect ease and with the ordinary service sponge, the Committee are of opinion that the batch of shot used in this experiment must have been of high gauge.

On another occasion a similar occurrence took place with the Whitworth gun as that above referred to with the Armstrong gun, a shell having jammed about four feet from the muzzle, which was only eventually forced down with very great difficulty.

Upon consideration of these experiments and the long course of practice they have witnessed with these guns, the Committee are of opinion that as regards ease of loading, the only instances of difficulty that have occurred with either gun have been so rare and obviously exceptional that they are unable in summing up to assign to either gun a decided advantage over the other in this respect.

The loading of the breech-loader would have been attended with perfect ease if it had

not been for the slight accumulation of foul deposit in the slot in which the wedge worked; the application of a little water was, however, found sufficient to remedy this inconvenience.

## VI.—RECOIL.

The recoil of the three competitive guns when fired with the proposed ordinary charges of 9 lbs. of powder for the breech-loader and of 10 lbs. for each of the muzzle-loaders was nearly equal, and although sharp, and especially so with the breech-loader, it was in no case unmanageable.

When the charges of the two muzzle-loaders were increased to 12 lbs. of powder, and those of the muzzle-loading Armstrong gun to 14 lbs., the recoil was increased, but not to such an extent as not to be perfectly under control with the improved appliances for checking recoil which have been proposed for adoption into the service.

## VII.—RAPIDITY OF FIRING.

The experiments made with the view of testing the rapidity with which the various guns are capable of being fired have been detailed under the head of ease of working. With a view of instituting a comparison between these various rifled guns and the old smooth-bored gun of the service with its spherical projectile, 20 rounds were fired on board H.M. ship "Excellent" from an 8-inch smooth-bored gun weighing 65 cwt., and throwing a hollow shot of 56 lbs. weight; the results of this experiment are recorded in the following Table for comparison with the series of 20 rounds which were fired from the respective rifled guns with the greatest rapidity and all under like circumstances.

| Nature of Gun.                     | Weight of Gun. | Weight of Shot. | 20 Rounds fired in |      | Rate per round. |
|------------------------------------|----------------|-----------------|--------------------|------|-----------------|
|                                    |                |                 | min.               | sec. | seconds.        |
| B. L. Armstrong 70-pr. rifle - - - | cwt. 61·6      | lbs. 70         | 7                  | 15   | 23              |
| Whitworth 70-pr. rifle - - -       | 77             | 70              | 10                 | 42   | 33·8            |
| M. L. Armstrong 70-pr. rifle - - - | 75             | 70              | 9                  | 55   | 31·3            |
| 8-inch smooth-bore - - -           | 65             | 56              | 8                  | 35   | 27              |

As regards rapidity of fire, it appears therefore that there is a decided advantage in favour of the breech-loader; while it would deliver 100 rounds, the Whitworth gun would deliver 68 rounds, and the muzzle-loading Armstrong 73 rounds.

The smooth-bored gun would have delivered 85 rounds in the same time.

## VIII.—CAPACITY FOR FIRING DIFFERENT KINDS OF PROJECTILES.

The following is a complete list, with details of their leading dimensions, of the various projectiles which have been submitted to the Committee by the competitors for use with the guns selected for trial as types of their systems of heavy Artillery.

| For the 70-pr. B.L. Armstrong Gun.                                                                                                                                                | For the 70-pr. Whitworth Gun.                                                                                                                                                                                                         | For the 70-pr. M.L. Armstrong Gun.                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Hollow-headed shot, cylindro-conoidal in form, coated with lead.<br>Length - - - 12·26 in.<br>Diameter - - - 6·43 "<br>Weight - - - 71·87 lbs.                                 | Solid shot, polygonal section, parallel sided, with round head, and tapered behind.<br>Length - - - 15·04 in.<br>Diameter { major 5·46 "<br>minor 4·98 "<br>Weight - - - 70 lbs.                                                      | Hollow-headed shot, cylindro-conoidal in form, with three rows of copper studs.<br>Length - - - 12·815 in.<br>Diameter - - - 6·34 "<br>Weight - - - 70 lbs.                                                |
| 2. Common shell (short), cylindro-conoidal in form, coated with lead.<br>Length - - - 14·66 in.<br>Diameter - - - 6·43 "<br>Weight empty - 64·2 "<br>Capacity for powder 4·8 lbs. | Common shells (short), polygonal section, parallel sided, with round head and tapered behind.<br>Length - - - 17·985 in.<br>Diameter { major 5·46 "<br>minor 4·98 "<br>Weight empty 67 lbs. 7 oz.<br>Capacity for powder - } 2 " 14 " | Common shell (short), cylindro-conoidal in form, with three rows of copper studs.<br>Length - - - 14·64 in.<br>Diameter - - - 6·34 "<br>Weight empty - 65·25 lbs.<br>Capacity for powder - } 4 lbs. 12 oz. |



| For the 70-pr. B.L. Armstrong Gun.                                                                                                                                                                                                                 | For the 70-pr. Whitworth Gun.                                                                                                                                                                                                                                                                                                                                                                                                        | For the 70-pr M.L. Armstrong Gun.                                                                                                                                                                                                                                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                    | Common shell (long).<br>Length - - - 21 in.<br>Diameter { major 5.46 "<br>{ minor 4.98 "<br>Weight empty - 69 lbs.<br>Capacity for powder 5 "                                                                                                                                                                                                                                                                                        | Common shell (long).<br>Length - - - 20 in.<br>Diameter - - - 6.24 "<br>Weight empty - 66.25 lbs.<br>Capacity for powder 9 lbs. 3 oz.<br>Studs made of zinc.                                                                                                                     |
|                                                                                                                                                                                                                                                    | Common shell, 5 diameters long.<br>Length - - - 27.5 in.<br>Weight - - - 82 lbs.<br>Capacity for powder 7 "                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                  |
| 3. Segment shell, cylindro-conoidal in form, coated with lead.<br>Length - - - 13.85 in.<br>Diameter - - - 6.43 "<br>Weight empty - 74.6 lbs.<br>Bursting charge :—<br>For sea service - 3 lbs.<br>For land service - 1 "<br>No. of segments, 112. | Shrapnel shell, polygonal section, parallel sided, with round head, and tapered behind.<br>Length - - - 15.58 in.<br>Diameter { major 5.46 "<br>{ minor 4.98 "<br>Weight empty 67 lbs. 5 oz.<br>Bursting charge 6 or 3 oz.<br>No of bullets :—<br>6 (large) - 9 to a lb.<br>180 (medium) 14 "<br>13 (small) - 34 "<br>Total 199                                                                                                      | Segment shell, cylindro-conoidal in form, with three rows of copper studs.<br>Length - - - 13.88 in.<br>Diameter - - - 6.34 "<br>Weight empty - 68.9 lbs.<br>Bursting charge :—<br>For sea service - 3 lbs.<br>For land service - 1 "<br>No. of segment, 98.                     |
| 4. Case shot.<br>Length - - - 17.15 in.<br>Weight - - - 72.56 lbs.<br>No. of balls - - - 247.                                                                                                                                                      | Case shot.<br>Length - - - 16.28 in.<br>Diameter - - - 4.99 "<br>Weight - - - 70.5 lbs.<br>No. of balls :—<br>Large, 84 ; small, 54 ; total, 138.                                                                                                                                                                                                                                                                                    | Case shot.<br>Length - - - 7.15 in.<br>Weight - - - 72.56 lbs.<br>No. of balls - - - 247.                                                                                                                                                                                        |
| 5. Nil.                                                                                                                                                                                                                                            | Steel shot (flat-headed), for penetrating iron.<br>Length - - - 12.66 in.<br>Diameter { major - 5.46 "<br>{ minor - 4.98 "<br>Weight - - - 71 lbs. 2 oz.                                                                                                                                                                                                                                                                             | Steel shot (round-headed), for penetrating iron.<br>Length - - - 9.9 in.<br>Diameter - - - 6.3 "<br>Weight - - - 69 lbs. 12 oz.                                                                                                                                                  |
| 6. Nil.                                                                                                                                                                                                                                            | Steel shell (without plug), for penetrating iron.<br>Length - - - 16.4 in.<br>Diameter { major 5.46 in.<br>{ minor 4.98 "<br>Weight empty 70 lbs. 5 oz.<br>Bursting charge, 2 lbs. 8 oz.<br>Steel shell (flat-headed), with plug for penetrating iron.<br>Length - - - 14.8 in.<br>Diameter { major 5.46 "<br>{ minor 4.98 "<br>Weight empty - 74 lbs. 2 oz.<br>Burst - - - 1 lb.<br>Length of plug 4 in.<br>Diameter - - - 2.25 in. | Steel spherical shot, for use against iron.<br>Diameter - - - 6.35 in.<br>Weight - - - 39 $\frac{1}{8}$ lbs.<br>Steel shell (round-headed), for penetrating iron.<br>Length - - - 12.21 in.<br>Diameter - - - 6.34 in.<br>Weight - - - 68 lbs. 7 oz.<br>Bursting charge - 2 lbs. |
| 7.                                                                                                                                                                                                                                                 | Rifled spheres.<br>Weight - - - 22 lbs.                                                                                                                                                                                                                                                                                                                                                                                              | Cast-iron spherical shot.<br>Service 32-pr.                                                                                                                                                                                                                                      |
| 8.                                                                                                                                                                                                                                                 | Flat-fronted shot, for penetrating under water.<br>Length - - - 13.4 in.<br>Weight - - - 69 lbs.<br>Flat-fronted shell, for penetrating under water.<br>Solid shot, best form for flight.<br>Length - - - 15.75 in.<br>Weight - - - 70 lbs.<br>Hollow shot, best form for flight.<br>Length - - - 15.75 in.<br>Weight - - - 60 lbs.                                                                                                  |                                                                                                                                                                                                                                                                                  |

## 1.—SOLID AND HOLLOW-HEADED SHOT.

From the experiments which have been detailed under the heads of range and accuracy, it will be seen that with the proposed service charges of 9 lbs. of powder for the breech-loader, and of 10 lbs. for each of the muzzle-loaders, the three guns are all capable of firing these projectiles with very great but not equal range and accuracy.

Subsequently, at the request of Sir W. Armstrong, 10 rounds of his hollow-headed shot were fired from his muzzle-loading gun at 5° of elevation, with charges of 14 lbs. of powder; the results, after elimination of one round, gave a mean range of 2,810 yards, and a mean radial distance of 122 inches, as shown in the first diagram. These rounds indicate that with these increased charges this gun has a superiority in range over the Whitworth gun, fired with the ordinary charge of 10 lbs., equivalent at this elevation to about 40 minutes of elevation, and that this augmentation in range is accompanied by increased accuracy.

At Mr. Whitworth's request the Committee caused some rounds to be fired with his solid shot with charges of 10 and 12 lbs., at an elevation of 33°. The results were as follows:—

| Elevation. | Charge. | No. of Rounds. | Mean Range. | Mean Error in Range. | Mean Error in Deflection. | REMARKS.                                              |
|------------|---------|----------------|-------------|----------------------|---------------------------|-------------------------------------------------------|
|            | lbs.    |                | Yards.      | Yards.               | Yards.                    |                                                       |
| 33°        | 10      | 4              | 9,442       | 38·3                 | 10·8                      | { Strong breeze down the range.<br>Very light breeze. |
|            | 12      | 4              | 9,542       | 12·5                 | 4·5                       |                                                       |
|            | 10      | 2              | 9,517       | 17·5                 | 7·5                       |                                                       |
|            | 12      | 4              | 9,592       | 20·5                 | 11·0                      |                                                       |

An inspection of this table shows that the increased charge gives but slight increase to the range of this gun.

## 2.—COMMON SHELL.

It will be seen from the preceding list of projectiles that one description of common shell has been submitted to the Committee for the breech-loader, three for the Whitworth gun, and two for the muzzle-loading Armstrong gun.

From what has preceded in treating of range and accuracy, it results that the guns of all three systems have proved themselves capable of firing the *short* common shells, with very great but not equal range and accuracy. The above practice took place with the proposed service charges of 9 lbs. for the breech-loader and of 10 lbs. for each of the muzzle-loaders.

Subsequently, at the request of Sir W. Armstrong, 10 rounds of short common shell were fired at 7° and nine rounds at 10° of elevation, with charges of 14 lbs. of powder, which augmented the ranges very considerably, making them superior in each case by more than 200 yards to the ranges of the Whitworth common shell fired at the same elevations with charges of 10 lbs.; this exemplifies in a marked manner the result obtained by the electro-ballistic pendulum, viz., that the muzzle-loading Armstrong gun is capable of consuming with advantage a 14 lbs. charge.

As will be seen, however, hereafter, although the range obtained by this gun with 14 lbs. of powder, at 7°, exceeded the range obtained with the Whitworth gun when fired with 11 lbs. at the same elevation by 148 yards, the Whitworth gun with charges of 11 lbs. exceeded the muzzle-loading Armstrong gun with charges of 14 lbs., at 10°, by 157 yards. This fact would apparently show that with these special charges the increased retardation of the Armstrong projectile reduces the effect due to its increased velocity to an equality with that of the Whitworth at a range of about 4,000 yards.

The radial distances also indicate, as in the similar experiment with shot, that the accuracy of the muzzle-loading Armstrong gun is very considerably improved at the higher velocities acquired by the projectiles when fired with these heavy charges. The practice at 10°, which was very limited in number of rounds, 9 only having been fired, is very remarkable in point of accuracy; Sir W. Armstrong having proposed 10 lbs. as the ordinary service charge for his gun, and 14 lbs. only as a special charge, the heavier charge of 14 lbs. was only tried for range and accuracy, among the rounds placed at his disposal by the Committee towards the conclusion of their experiments; the Committee, therefore, regret that they had no opportunity of enlarging these experiments, and also of testing the gun for endurance with these charges.



The following table gives the results of this practice, which are also indicated on the second diagram.

Muzzle-loading Armstrong gun ; capacity, 4·75 lbs.

| Elevation. | Charge. | No. of Rounds. | Mean Range.     | Mean Radial Distance. |
|------------|---------|----------------|-----------------|-----------------------|
| 7°         | 14 lbs. | 9              | Yards.<br>3,578 | Inches<br>263         |
| 10°        | "       | 9              | 4,427           | 164                   |

The Committee observe, however, that Mr. Whitworth's short shell contains only 2·875 lbs. of powder, whereas Sir W. Armstrong's short shell for his muzzle-loading gun contains 4·843 lbs., and therefore as the penetration of this latter shell appears to be sufficient at all practical ranges to ensure the effective action of the bursting charge as a mine, it must from its larger capacity be decidedly superior in its destructive effects to the short common shell fired from the Whitworth gun.

The same destructive effects might be expected from the common shell of the breech-loading as from that of the muzzle-loading Armstrong gun, but from the reduced charges, and comparatively diminished velocity with which it is fired, it does not appear to obtain that penetration into all substances at moderate ranges which will ensure the bursting of the charge with full effect. This observation does not apply to the use of this gun against wooden ships, or defences offering but moderate resistance to penetration.

The Committee have also to report that in their practice for range and accuracy with short common cast-iron shell, which comprised about 150 rounds from each gun, with the proposed service charges, two shells broke up in the Whitworth gun, whereas there was no such occurrence with either of the Armstrong guns.

Mr. Whitworth, however, has always proposed that the want of capacity in his shells, due to the smallness of his calibre as compared with Sir W. Armstrong's, should be compensated by the use of shells of greater length. He therefore submitted the long shells described in the foregoing table, which are capable of containing 5 lbs. of powder each.

With a view to testing the accuracy of the Whitworth gun when fired with these long shells, the Committee caused 44 rounds to be fired with them, with the proposed ordinary service charges of 10 lbs. of powder at 4° and an equal number at 10° of elevation. The ranges in each case were nearly identical with those of the short shell, but with somewhat less accuracy at 4° and with about equal accuracy at 10° of elevation. The results are shown in the following table, and also on the second diagram.

Whitworth long shell ; capacity, 5 lbs.

| Elevation. | Charge. | No. of Rounds. | Mean Range.     | Mean Radial Distance. |
|------------|---------|----------------|-----------------|-----------------------|
| 4°         | 10 lbs. | 40             | Yards.<br>1,960 | Inches.<br>144        |
| 10°        | "       | 40             | 4,278           | 406                   |

The Committee further carried on a series of experiments in Portsmouth harbour, by firing a number of rounds from the guns which, for this purpose, had been placed on board the "Stork" gunboat, at a distance of about 700 yards from the "Alfred," an old wooden frigate, used as a target.

In all cases the shells when they struck passed through the ship's side, which was of oak, varying from 17 to 29 inches in thickness. In consequence of the varying resistance of the "Alfred" in its various parts, and its very dilapidated condition, caused by long previous use as a target ship, it was impossible to form an accurate estimate of the relative destructive effect of the shells. Accordingly, the results noted were not such as to show a decided superiority of either shell, but the Committee are of opinion that, on the whole, the effects of the Armstrong short shell and Whitworth long shell (21 inches) were about equal, but that, being of larger capacity, the Armstrong shell were both more destructive in their effects than the Whitworth short shell.

None of Mr. Whitworth's long shells broke up in the gun when fired with the pro-

posed service charge, but subsequently, in firing 60 rounds with charges of 11 lbs., one of them did so.

The results obtained from these 60 rounds, which were fired, at the request of Mr. Whitworth, in series of 20 each at 4°, 7°, and 10° of elevation, showed, as might have been expected from the experiments with the electro-ballistic apparatus previously recorded, that this addition of one pound to the charge produced no very material increase to the ranges, and did not affect the accuracy of the practice, the results of which are shown in the following table, and also on the second diagram.

Whitworth long shell ; capacity, 5 lbs.

| Elevation. | Charge. | No. of Rounds. | Mean Range. | Mean Radial Distance. |
|------------|---------|----------------|-------------|-----------------------|
|            |         |                | Yards.      | Inches.               |
| 4°         | 11 lbs. | 17             | 2,179       | 174                   |
| 7°         | "       | 18             | 3,430       | 305                   |
| 10°        | "       | 18             | 4,584       | 389                   |

Sir W. Armstrong also produced some long shells for his muzzle-loading gun, capable of containing, as described in the foregoing list of projectiles, the enormous bursting charge of 9·2 lbs. Ten rounds were fired with these shells at 4° and 15 rounds at 10° of elevation, with charges of 12 lbs. of powder. The results are shown in the following table, and also laid down on the second diagram.

Armstrong long shell ; capacity, 9·2 lbs.

| Elevation. | Charge. | Rounds. | Mean Range. | Mean Radial Distance. |
|------------|---------|---------|-------------|-----------------------|
|            |         |         | Yards.      | Inches.               |
| 4°         | 12 lbs. | 9       | 2,112       | 86                    |
| 10°        | "       | 14      | 4,086       | 425                   |

It will be seen that at both elevations the range was superior, as compared with the short shells fired with the ordinary service charges of 10 lbs. from the same gun ; the accuracy was greater at the shorter range, and about the same at the longer range as that of the short shell fired from the Whitworth gun with the proposed service charge. At the lower elevation the range was longer and the accuracy considerably greater than with the long shell fired from the Whitworth gun, with charges of 10 lbs. of powder, and at the higher elevation the range and accuracy were nearly equal, although both slightly in favour of the long Whitworth shell, also fired with charges of 10 lbs. ; it should be observed, however, that the Whitworth long shell fired with charges of 11 lbs., although equal in range and very inferior in accuracy at 4°, maintained a marked superiority in range and accuracy at 10°.

The Committee observe that the capability of Sir W. Armstrong's muzzle-loading gun for throwing shells of such large capacity gives it great destructive powers, which for certain purposes of war must be of very great value.

Mr. Whitworth also submitted some common shell 5 diameters in length, capable of containing 7 lbs. of powder, which at his request were fired with reduced charges of 1, 2, and 6 lbs. of powder at elevations of 33°.

The object of this experiment appears to have been to show that his gun could be used for vertical firing with special shells containing an extra large charge of powder. Twenty rounds only were fired ; so far as they go they appear to indicate that the gun, which at such high elevations is more awkward and difficult to serve than a mortar, can be used with fair results for vertical fire. The records of this practice are shown in the Appendix, and the results in the following table.

Whitworth common shell ; 5 diameters long ; capacity, 7 lbs.

| Charge. | No. of Rounds. | Mean Range. | Mean Error in Range. | Mean Error in Deflection. |
|---------|----------------|-------------|----------------------|---------------------------|
| lbs.    |                | Yards.      | Yards.               | Yards.                    |
| 1       | 7              | 1,221       | 21·1                 | 0·6                       |
| 2       | 7              | 2,595       | 42·1                 | 2·1                       |
| 6       | 3              | 7,148       | 63·3                 | 6·3                       |



## 3.—SEGMENT AND SHRAPNEL SHELL.

From the description given of Sir W. Armstrong's segment shells in the foregoing list of projectiles, it will be seen that the shells for his breech and muzzle-loading guns are constructed on the same principles, and very nearly coincide so far as their form and internal arrangements are concerned; the segments of the shells for the muzzle-loading gun are rather fewer in number, but as this gun was more nearly on an equality with the Whitworth as regards charge and range than the breech loader, and the experiments are most laborious and expensive, the Committee considered it necessary only to test the destructive effect of the segment shell from the muzzle-loader in competition with Colonel Boxer's shrapnel shell as fired from the Whitworth gun. The experiments for this purpose were made by firing the respective shells at three lines of deal targets, two inches thick, placed one behind the other at intervals of 10 yards, to represent columns of troops, and bursting them either on graze, or by firing them through screens in front of the targets, as explained in the preliminary report of the Committee at page xxxvi.

The following table gives the results of the practice when the shells were burst by firing them through screens.

| Shell burst in front of leading Target at a distance of yards. | Range.     | Length of Targets, 9 feet high. | Number of Rounds. | Mean Hits per Round. |           |           |        |                  |           |           |        |
|----------------------------------------------------------------|------------|---------------------------------|-------------------|----------------------|-----------|-----------|--------|------------------|-----------|-----------|--------|
|                                                                |            |                                 |                   | Whitworth.           |           |           |        | M.-L. Armstrong. |           |           |        |
|                                                                |            |                                 |                   | 1st Line.            | 2nd Line. | 3rd Line. | Total. | 1st Line.        | 2nd Line. | 3rd Line. | Total. |
| 100                                                            | Yards. 800 | Feet. 54                        | 3                 | 68                   | 55        | 30        | 153    | 5                | 2         | 5         | 12     |
| 50                                                             | 800        | 54                              | 3                 | 144                  | 115       | 87        | 346    | 32               | 19        | 8         | 59     |
| 10                                                             | 800        | 54                              | 3                 | 113                  | 115       | 106       | 334    | 35               | 69        | 51        | 155    |
|                                                                |            |                                 | Total             | 325                  | 285       | 223       | 833    | 72               | 90        | 64        | 226    |

From the foregoing table, which is deduced from those hits only in which the fragments either passed through or lodged in the targets, it will be seen that the shrapnel shell has a very marked superiority over the segment shell when burst by the action of a time fuze, which it maintains in all the relative positions in which the shells were burst, and that the bullets and fragments of the shrapnel retained sufficient force to pass through the three lines of two-inch targets, when burst at distances of 100 yards from the leading target, whereas the force of the segments appears to be nearly expended within that distance. The Committee attach very great importance to this fact, as instances will very frequently occur on service when the effect of the shell must depend entirely on the time fuze; and the retention of their velocity and direction by the bullets and fragments renders the effect of the shell when so burst much more independent of the accurate judgment of distance and adjustment of the fuze by the men who serve the gun.

The Committee have further to observe, that the distribution of the bullets of the shrapnel shell, when burst at 100 yards and at 50 yards from the leading target, is very perfect; but that, when burst at 10 yards from the leading target, the distribution of the fragments of both descriptions of shells was rather more concentrated than could be desired, both guns having, in addition to the recorded hits, cut away large fragments of the targets.

The Committee further caused a number of rounds to be fired at a range of 800 yards, at three lines of 2-inch targets, 9 feet high and 54 feet in length, placed at intervals of 10 yards, so that the shells should burst by the action of the percussion fuzes on grazing on the sands.

Only seven rounds, in which the grazes were from 15 to 60 yards in front of the leading target, gave results which could be compared; from these, the mean number of hits on the targets, counting only those which passed through or lodged, are as follows:—

| Targets,<br>9 feet high, 64 feet long. |   |   |   | Whitworth. | Muzzle-loading<br>Armstrong. |
|----------------------------------------|---|---|---|------------|------------------------------|
| First line                             | - | - | - | 80         | 55                           |
| Second line                            | - | - | - | 42         | 41                           |
| Third line                             | - | - | - | 26         | 18                           |
| Totals                                 | - | - | - | 148        | 114                          |

These results exhibit a superiority in favour of the shrapnel shell when burst on graze on the sands at Shoeburyness, which, as the Committee observed in their preliminary report, present far more favourable conditions for such practice than would generally be met with on service.

The records of those rounds of segment shell, which were fired from the muzzle-loading Armstrong gun, and burst on graze at distances varying from 60 to 115 yards in front of the leading target, but for which corresponding rounds were not obtained with the Whitworth gun, gave the following results :—

|             |   |   |                    |
|-------------|---|---|--------------------|
| First line  | - | - | 19 hits per round. |
| Second line | - | - | 8 do. do.          |
| Third line  | - | - | 1 do. do.          |
| <hr/>       |   |   |                    |
| Total       | - | - | <u>28</u> do. do.  |

This would appear to show that segment shells when burst on graze, even on the most favourable ground, at greater distances than about 50 yards in front of troops, are comparatively ineffective, although superior to the same shells when burst by time fuze at equal distances in front of them.

These experiments show that in order to produce an effective fire with segment shell, whether burst by graze or by the action of the time fuze, the range must be known with very great accuracy, as these shells are in neither case comparatively effective when burst at distances of more than 50 or 60 yards in front of troops. The most effective manner of employing them is by bursting them by time fuze close in front of troops, at from 10 to 30 yards from them; but even when so used they are far inferior to the shrapnel shell when burst under like circumstances with the guns now under consideration; and these latter are as effective when burst by the action of the time fuze at 100 yards in front of troops as the segment shell when burst under the most favourable conditions for the development of its destructive effect.

The above practice all took place with the land service burster of one pound, but Sir W. Armstrong stated to the Committee that the larger bursting charge which the segment shell is capable of containing is intended to produce a destructive effect on the crew by the greater dispersion of the fragments after passing through the side of a ship; the Committee did not deem it absolutely necessary to try this experiment, as they consider that such employment of a segment shell would be exceptional, and, moreover, the target ship sunk so that the experiment could not be made without great delay.

The Committee have further to report, that in the course of their practice for range and accuracy, in which about 150 rounds have been fired with these shells, no segment shell broke up in the breech-loading Armstrong gun, 18 shrapnel shell broke up in the Whitworth, and two segment shell in the muzzle-loading Armstrong gun, a proportion which is greatly against the shrapnel shell as fired from the Whitworth gun; but they consider that this defect is one which is capable of being remedied in both, not being in either case inherent in the principle on which the shell depends for its destructive effect, but consequent on the want of strength in the projectile itself.

Upon reviewing the whole of the practice from the 70-pounders with these projectiles, the Committee have to report their opinion that Colonel Boxer's shrapnel shell is a far more formidable projectile for the general requirements of war than Sir W. Armstrong's segment shell.

The value of this shell has been exhibited in a far higher degree with the heavy than with the light guns, and the Committee do not hesitate to recommend the principle of the shrapnel strongly in preference to that of the segment shell.

#### 4.—CASE SHOT.

In order to test the relative effect of the various case shot submitted to them, the Committee caused a number of rounds to be fired at ranges of 500, 300, and 100 yards at a line of 2-inch deal targets, 9 feet high, and 54 feet in length.

As it appeared that case shot when fired from these guns at elevations exceeding 2° is not effective, the results of those rounds only are compared, which were fired at elevations of 2° or less.

Four rounds fired at a range of 500 yards at 1½° and 2° of elevation, gave the following as the mean number of hits per round, counting only those which passed through or lodged in the target :—

|                              |   |   |          |
|------------------------------|---|---|----------|
| Breech-loading Armstrong gun | - | - | 52 hits. |
| Whitworth gun                | - | - | 39 „     |
| Muzzle-loading Armstrong gun | - | - | 35 „     |



Three rounds fired at a range of 300 yards at  $1^{\circ}$  of elevation, and three more at an elevation of  $\frac{1}{2}^{\circ}$  gave a mean number of hits per round, as follows:—

|                              |   |   |   |   |           |
|------------------------------|---|---|---|---|-----------|
| Whitworth gun                | - | - | - | - | 123 hits. |
| Muzzle-loading Armstrong gun | - | - | - | - | 45 „      |

Only three rounds were fired from the breech-loading Armstrong gun, at the range of 300 yards at an elevation of  $\frac{1}{2}^{\circ}$ , giving a mean of 61 hits per round.

Six rounds fired at a range of 100 yards gave a mean number of hits per round, as follows:—

|                          |   |   |   |   |     |
|--------------------------|---|---|---|---|-----|
| Whitworth                | - | - | - | - | 170 |
| Muzzle-loading Armstrong | - | - | - | - | 122 |

From these results it appears that at ranges of 500 yards, case shot is comparatively of little effect when fired from either gun; that at 300 yards it is effective from the Whitworth gun, while the effect remains small from the Armstrong guns, and that at 100 yards the case shot fired from the muzzle-loading Armstrong gun is about as effective as the case shot fired from the Whitworth gun at 300 yards, and that the case shot from the Whitworth is much the most effective at 100 yards range.

The Committee have to observe that one of the case shot fired from the muzzle-loading Armstrong gun did not break up, but passed whole over the target at a range of 500 yards, and to call attention to the fact that the superior effect of Mr. Whitworth's case shot is produced by a projectile weighing 70·5 lbs. as against a projectile fired from Sir W. Armstrong's guns weighing 72·56 lbs.

The experiments therefore with the heavy guns entirely confirm the opinion given by the Committee in their preliminary report with reference to field guns, that Mr. Whitworth's case shot is an invention of very great value to Her Majesty's service.

#### 5.—STEEL SHOT.

Sir W. Armstrong, considering his breech-loading gun too light for effective use against iron ships of the "Warrior" class, withdrew it from the competition with the muzzle-loading guns in this respect. As Sir W. Armstrong did not propose to fire a heavier charge than 9 lbs. with this gun, the Committee consider that such guns are not applicable when the high velocities are required which are necessary for the attack of iron plates.

The steel shot proposed by Mr. Whitworth for penetrating iron are flat-headed, whereas those proposed by Sir W. Armstrong are round-headed; and at short ranges Sir W. Armstrong also proposed to use spherical shot.

In order to test their relative effects, these shot were fired at a "Warrior" target, 20 feet long and 10 feet high, at ranges of 50, 200, 600, and 800 yards. From the great expense and delay inseparable from experiments, in which the target is so exceedingly expensive and requires so long a time for its preparation, this practice has necessarily been of a limited nature, and more especially so as the same target had to be used for trying the effects of steel shells.

The accurate observation of the exact amount of injury done by each shot against a target of this nature is attended with great difficulty, as it is impossible to ascertain the effects produced by shot or shell on the fastenings and internal parts of the target, except so far as they may be visible externally; and, therefore, an injury which may in reality have been inflicted by a preceding shot may possibly only be attributed to a subsequent shot, as, for instance, a bolt may be cracked through or seriously strained by one shot, and the injury only made visible by the head of the bolt being started from its place by a subsequent shot; and where a large number of shot and shell have been fired against a target of the comparatively small dimensions of 10 by 20 feet, it may readily be conceived that the unseen effects of the few rounds first fired may give an undue importance to the effects of those which have followed them.

Having premised thus much, the Committee proceed to record the results of this practice.

At ranges of 50 yards the elongated shot, weighing 69·75 lbs., fired with a charge of 14 lbs. of powder from the muzzle-loading Armstrong gun, was more effective than the elongated shot, weighing 71·75 lbs., fired with a charge of 12 lbs. from the Whitworth gun. Both shot struck in fair positions for comparison; the Armstrong shot remained embedded in the target, with its base 3·7 inches within the face of the plate, giving a penetration of nearly 13·6 inches, bulging and slightly cracking the skin, whereas the other was embedded in the plate, but with 2½ inches of its rear end projecting, showing an actual penetration not exceeding 10·16 inches.

A round was also fired from the Armstrong gun at this range (50 yards), with a steel spherical shot weighing 39·87 lbs., and a charge of 18 lbs. of powder. The effect was less than that of the elongated shot fired from the same gun with 14 lbs.

One elongated shot, weight 69·75 lbs., was fired from the muzzle-loading Armstrong gun, with 14 lbs. of powder, in competition with a shot, weight 71·12 lbs. from the Whitworth gun with 12 lbs. at a range of 200 yards.

The Whitworth shot struck on the joint of two plates, penetrated about 9·16 inches, and broke three bolts, whereas the Armstrong struck full on the plate, penetrated about 17·9 inches, and slightly bulged the skin of the ship, an effect which was decidedly favourable to the Armstrong projectile.

One round was fired from each gun also, with their respective elongated steel shot and the same charges, at a range of 600 yards. The Armstrong shot lodged, leaving one inch of its rear end projecting; the Whitworth also lodged, but with five inches projecting. As the length of the former was originally 9·9 inches, and of the latter 12·6 inches, it is evident that the Armstrong shot had the greatest penetration.

Two rounds also were fired from each gun, with similar shot and charges, at a range of 800 yards. One Armstrong shot hit the target about one foot from its edge, broke the plate, driving the fragment in five inches, but rebounded, having shortened to eight inches, and doing no damage in-board; the other struck the edge of the target, and therefore was of no use for comparison. One of the Whitworth shot penetrated the plate and broke up, part remaining in the target; one armour bolt was broken and another started; the other shot penetrated the plate and remained embedded its whole length, which was 12·66 inches.

These experiments tend to show that at ranges up to and including 600 yards, both guns being fired with the highest charges proposed by their respective inventors for use when the penetrative powers of their guns have to be developed to the utmost, the Armstrong muzzle-loading gun had an advantage over the Whitworth gun in the penetration of iron, by virtue of its larger calibre, notwithstanding the greater work that had to be accomplished by its projectile; but that at ranges of 800 yards the Whitworth gun had the greater penetrative power.

Having been unable to test the accuracy of these projectiles from the small number of rounds fired at the "Warrior" target, the Committee applied for a number of shot to be made of cast iron, on the same models as the steel shot with which this practice was conducted, in order to enable them to form a judgment as to the relative accuracy of the guns when fired with these projectiles at moderate ranges, but failed to obtain them. They, however, have to report that they consider it of very great importance that experiments should be made for testing the accuracy of these shot, as well as of steel shell of the patterns with which their experiments have been conducted, as a gun with high powers of penetration, capable of shooting accurately at moderate ranges, must, under certain circumstances, have a great advantage over a gun which, without the same penetrating power and accuracy at moderate ranges, has a more formidable battering effect at short ranges.

As it must be of comparatively rare occurrence on service that shot impinge perpendicularly upon plates, as in the preceding practice, where the guns were placed at short ranges, directly opposite to the targets, the Committee were particularly desirous of trying the power of penetration of the various projectiles when fired so as to impinge upon the plates in an oblique direction. For this purpose two plates,  $4\frac{1}{2}$  inches thick, 15 feet long by 3 feet 4 inches broad, were laid upon strong wood frames, inclining at an angle of  $52^\circ$  from the vertical. The guns were placed opposite to them at a distance of 200 yards, when three rounds were fired from each with their respective elongated shot and charges of 12 lbs. of powder for the Whitworth and of 14 lbs. for the muzzle-loading Armstrong gun. In this practice Mr. Whitworth requested that his gun might be fired with 10 lbs. of powder, as he considered, from the experiments which had already taken place before the Committee, that his gun is not capable of consuming more than that charge with effect, but as the previous practice against iron plates had been conducted at Mr. Whitworth's request with charges of 12 lbs. the Committee decided to adhere to those charges.

The Whitworth shot were all flat-headed; the effect of the first was to make an indentation 15 inches long, 6 inches broad, and 3 inches deep, bulging and cracking the plate; the shot of the other two rounds produced a rather less effect.

The Armstrong shot, which were round-headed, broke in each case without passing through the plate, but large pieces were torn off the back of the plate and driven to the rear, and at the first round a hole about two inches square was driven through the plate, upon which there was an indentation 15 inches long by 7 inches broad. At



the other rounds the plate was more or less cracked through the indentations being  $4\frac{1}{2}$  and  $5\frac{1}{2}$  inches deep.

These results corresponded with those obtained by the direct practice against the "Warrior" target, and proved that the very high velocity due to the heavy charge of 14 lbs. is sufficient to obtain a greater penetration with the larger sectional area of the Armstrong projectile, than the lower velocity with the less sectional area of the Whitworth projectile.

The Committee were most desirous of continuing these experiments, with a view to ascertaining whether the differently formed heads of the projectiles would give either an advantage in penetrating plates obliquely at longer ranges, when their velocities are diminished, but were obliged to discontinue them in consequence of the danger attending these experiments upon the narrow space included within the limits of the War Department property at Shoeburyness.

They therefore applied for authority to order some steel shot and shell to fire at an armour-plated floating battery, the use of which as a target had been approved by the Lords of the Admiralty; but the Secretary of State for War considered it of such importance to ensure an early report from the Committee that he was unwilling to delay it by sanctioning the issue of further projectiles.

It is with regret, therefore, that the Committee have been obliged to discontinue this very important branch of their inquiry.

#### 6.—STEEL SHELL.

No steel shells were submitted by Sir W. Armstrong for use against iron plates with his breech-loading gun. The dimensions, weights, &c., of the steel shell submitted by the competitors for use against iron with their respective muzzle-loading guns are given in the preceding list of projectiles.

Mr. Whitworth in the first instance proposed a common steel shell, 70·3 lbs. weight, and carrying a bursting charge of 2·5 lbs., which was fired in competition with a common shell from Sir W. Armstrong's muzzle-loading gun, 68·4 lbs. weight, and carrying a bursting charge of 2 lbs.

The distinctive peculiarities of these shells may be stated as follows:—The body of Sir W. Armstrong's shell is cylindrical, made of steel 1·34 to 1·84 inches thick, the head is formed of a cast-iron screw cap, which, when in its place, gives to the projectile a form approximating to the cylindro-conoidal; the bursting charge is introduced by the temporary removal of the head, there is no fuze or any special arrangement for the ignition of the bursting charge, which is intended to be ignited by the heat generated on impact; the shell is not intended to break up on the explosion of the bursting charge, but after penetration to deliver the full effect of the charge to the front.

Mr. Whitworth's shell is composed entirely of steel ·84 inches thick, and is flat ended, the head being solid and the base a screw plug, by the temporary removal of which the bursting charge is introduced; there is no special arrangement for igniting the charge which is intended to be ignited in the same manner as in the Armstrong shell; the shell after penetration is intended to break up on the explosion of the bursting charge, and to deliver its effects in every direction.

One of each of these shells was fired against a "Warrior" target, at ranges of 50, 200, 600, and 800 yards, with charges of 12 lbs. of powder from the Whitworth, and of 14 lbs. from the Armstrong gun.

The first round fired from the Whitworth gun at 50 yards struck full on a plate, while that from the Armstrong gun struck on a joint between two plates; as this latter, therefore, did not meet with the same amount of resistance as the former, another round was fired from the Whitworth gun to hit on a joint for the purpose of allowing a fair comparison to be made of the relative effects of the two shells. This Whitworth shell passed through the plates and burst; its penetration was 18 inches; one bolt was started forwards; in-board, the skin was bulged, three backing bolts and one armour bolt were broken, and one rib cracked. The Armstrong shell passed through the plates, driving the fragments in 9·25 inches from the front of the plate; the bursting charge set fire to the timber backing; the shell did not break up but was thrown back 20 yards, one bucket of water sufficed to extinguish the fire; the lower armour plate was forced ·5 inch outwards, nine of its bolts were started to the front, having been broken off in-board, and in addition one backing and one armour bolt started in-board. In this round the Whitworth shell appears to have obtained greater penetration and having a larger bursting charge, it might have been expected that its destructive effect on the target would have been superior to that of the Armstrong shell, whereas the destructive effect of the Armstrong shell was decidedly superior to that of the Whitworth; this the

Committee consider must be attributed to the manner in which the bursting charges take effect.

At the range of 200 yards the Whitworth shell struck full on a plate, and the Armstrong shell again on a joint between two plates, the effects therefore of these two shells could not be compared; it is interesting, however, to observe that the Armstrong shell penetrated the plates but without entering the backing quite to the same depth as it did at 50 yards, and that it acted precisely in the same manner as the shell which was fired at 50 yards; the bursting charge seems to have taken effect after the shell had penetrated the armour, and to have exerted its force in moving a plate breaking a considerable number of its fastenings.

The Whitworth shell which struck full on the plate obtained good penetration and burst, but the damage done to the target was very trifling.

At 600 yards the shell from the Whitworth gun struck close to a fracture caused by a former shell, whereas the Armstrong shell struck full on a plate. It was evident therefore that these rounds could not be compared; the destructive effects caused by these shell were insignificant.

The shells at 800 yards struck full on the plates in fair positions for comparison. The Whitworth shell made an indentation 4.25 inches deep, exploding on the outside and driving the plate half an inch inwards. The Armstrong shell made an indentation of 2.5 inches, the charge exploded but without breaking the shell, which was blown by it 400 yards back nearly in a direct line towards the battery. At this range the Whitworth gun had a decided advantage as to penetration, but neither of the bursting charges produced any useful effect.

The Whitworth shell fired at 800 yards and the Armstrong shell fired at 600 yards also struck the target in very favourable positions for comparison. The effect of the Whitworth shell has been already described. The Armstrong shell made an indentation 1.5 inches deep, the bursting charge ignited, and several bolts were slightly started in-board. From these results it would appear that the Whitworth shell fired at 800 yards with a charge of 12 lbs. of powder has a greater penetration than the Armstrong shell fired at 600 yards with a charge of 14 lbs. of powder.

The results of the above practice with steel shell show that the bursting charge in the Armstrong shell, which is loaded from the front, has a more destructive effect than that of the Whitworth shell which is loaded through the base, but the penetration of the former is not so great as that of the latter.

Subsequently Mr. Whitworth produced some steel shell of a peculiar construction, flat-headed and having steel plugs 4 inches long, and 2.1 inches in diameter fitted in the front part of their cavities; these plugs are intended to be driven forward by the charges in the shells, which are reduced to one pound, acting upon them similarly to the charge upon a shot in a gun; by this action after the shells have done their work of penetration the plugs are to be forced through the inner skin of the target. A detonating arrangement fitted to a screw plug at the base of the shell, ignites the charge in it, and is so contrived that the ignition shall not take place until the penetration of the body of the shell shall have ceased or nearly ceased.

Two rounds were fired with these shells at a range of 400 yards, one of them struck the target in an old hole, the other struck on a sound part, buried itself its whole length, and bulged the inside skin.

Four rounds were also fired with these shells at a range of 600 yards. The first entered the target, the burster was fired, the base of the shell being 3.3 inches inside the face of the target. The plug was driven by the burster through the iron skin, carrying with it the portion of the plate struck and a large piece of the iron skin; no bolts were broken; this shell acted exactly as intended by Mr. Whitworth. The second shell struck in line with the timber supports of the target, the bursting charge exploded, driving the piece of the plate struck and the plug of the shell against the iron skin, which was slightly bulged, the shell itself was driven out backwards 74 yards. The third struck in an old hole, and the fourth struck near an old fracture on a part of the target which is backed by a vertical stringer; the piece of the plate struck was driven against the skin and the shell was forced backwards a distance of 104 yards.

With reference to this peculiar shell the Committee have to observe, that, although undoubtedly a greater penetration has been obtained with it, and a ship's side may be pierced through by its plug, where it otherwise would not be by an ordinary steel shell from the same gun, the injury actually done to the ship by a hole of this nature would be considerably less than by getting the full effect due to the explosion of a larger charge of powder lodged in a shell in the ship's side, or to the effect of the same shell bursting within the ship, if it should have sufficient power to pass through its side.



## 7.—RIFLED SPHERES.

At Mr. Whitworth's request a number of projectiles, termed by him "rifled spheres," were fired both at Shoeburyness and Portsmouth; these consist in shot which have been cast spherical to the calibre of the major axis of the gun, with an allowance for windage, and afterwards rifled in a lathe. The practice was carried on with single spheres at targets nine feet square at ranges of 1,000 and 1,500 yards, with results which, considering that no previous practice with these projectiles had taken place, and that no range tables therefore had been made, may be considered fair.

Some rounds also were fired, in which three of these spheres were entered one over the other, in some cases with wads intervening between them, and in others without. The spheres appeared to separate, but generally not to any great extent, at a range of 500 yards, and in all cases they ricocheted in a good line, but when fired without intervening wads there appears to be a risk of their breaking up in passing out of the bore.

Mr. Whitworth stated that the object of these rifled spheres is for use against boats, but the Committee doubt the advisability of introducing into the service the complication attendant upon a special projectile for exceptional uses, when as good, if not better results may be expected from projectiles of the ordinary natures.

Sir W. Armstrong has proposed the employment, when thought advantageous, of the cast-iron spherical shot, intended for use with the 32-pounder smooth-bored gun of the service. Undoubtedly the mode of rifling and identity of calibre of his rifled 70-pounder gun with the service 32-pounder permits of the spherical projectiles which have been prepared for use from the smooth-bored gun being fired from the rifled gun, but the practice with these projectiles from the rifled gun must be comparatively inaccurate and the effect in no degree proportionate to that of the heavier rifled projectiles; the Committee, therefore, do not attach any importance to this identity of calibre, which they consider of little or no moment in determining the size of the bore of a rifled gun.

## 8.—FLAT-FRONTED SHOT and SHELL for penetrating under WATER.

Mr. Whitworth having proposed shot and shell of a particular form intended for penetrating under water, the Committee at his request tried the shot by causing several rounds to be fired at the "Alfred" target ship from on board the "Stork" gun-boat, at a distance of between 20 and 25 yards. The gun was depressed so as to strike the side of the ship, which was oak built, and from 22 to 24 inches thick, about two feet below the water line. The result showed that the projectile after striking the water about ten yards from the ship's side is just capable of passing through 24 inches of timber at a depth of 3·75 feet below the surface of the water. No similar experiment was made with any other projectile, and therefore the Committee have nothing with which to compare these results.

## IX. — CAPABILITY OF STANDING THE ROUGH USAGE OF ACTUAL SERVICE.

In the course of the experiments conducted by the Committee one of each of the competitive guns was fired 3,000 rounds, the breech-loader with charges of 9 lbs. and the two muzzle-loaders with charges of 10 lbs. of powder, after which each was fired thirty rounds at 6° of elevation for comparison with a number of rounds fired at the same elevation at the commencement of the experiments, the object being to ascertain the effect this long continued practice might have had upon the range and accuracy of the respective guns.

It appears from an examination of the results which are given in the Tables at pp. 2 and 6 of this Report, that the range was almost identical in each case before and after this protracted firing, and that the accuracy was not materially affected. This might have been expected with the breech-loading gun, the rifling of which was not in the least injured, and the results prove that the wear reported in the rifling of the two muzzle-loading guns was not to such an extent or of such a nature as to have been injurious.

At the 1,600th round the wrought-iron coil immediately over the steel barrel of the breech-loading gun exhibited a crack extending 11 inches along the chase in front of the first strengthening coil; upon examining the bore of the gun it was found that

the grooves underneath the crack were about half filled with lead, so that the projectile, in travelling along the bore, must have expanded it on passing this obstacle to a greater extent than the coiled iron was capable of resisting; the steel barrel was slightly expanded but otherwise uninjured; that this crack did not injuriously affect the strength of the gun is shown by 1,430 service rounds, and 102 rounds of excessive charges, for the purpose of breaking up the gun, having been subsequently fired without enlarging the crack or rendering the gun unserviceable.

The Committee also caused five shells to be burst in each gun, in order to ascertain the effect which might result from the action of their splinters, similar to what happens when shells explode prematurely. The shells used with the Armstrong guns were the ordinary common shells, containing 4.75 lbs. of powder; those used with the Whitworth gun were the long shells, containing a bursting charge of 5 lbs. These explosions produced no effect whatever on the bores of the guns.

Upon final examination, after having fired 3,000 rounds, the breech-loading Armstrong gun exhibited scarcely any signs of wear or deterioration in the bore, except at the breech end, into which, after 941 rounds, a steel bouch ring had been screwed to make good the surface of the bore where it had begun to wear by the escape of gas past the breech-loading apparatus. This ring was renewed after 487 rounds, again after the gun had fired 373 more rounds, and again after 335 rounds, when it lasted until the end of the firing.

The mitre of the cupholder which enters the bottom of the bore was repaired in consequence of an escape of gas after the gun had fired 768 rounds, and again after it had fired 133 more rounds; a third time after 40 more rounds; a fourth time after it had fired 860 more rounds; after which it stood 335 rounds; the cupholder was then changed, having lasted altogether 2,136 rounds. The vent-lock plate was replaced later the 319th round, slightly repaired after the 1,127th and 1,281st rounds; and in consequence of the slide for the locking pin having broken at the 1,800th round, the gun was fitted with a new slide and cover, which remained good until the end of the experiments.

The expansion of the bore of this gun was exceedingly small, being less than .02 of an inch everywhere except under the crack in the chase above referred to, where it amounted to .12 of an inch.

After the Whitworth gun had been fired 3,000 rounds, there were considerable fissures in the bore extending from the bottom to a distance of 48 inches from it, in each angle of the rifling; the deepest of these fissures was on the upper side, and from the impression showed a depth of about .2 of an inch; the bore was also very much scored by the gas all round for a distance of 48 inches from the bottom, which was also much worn in the angles of the rifling.

The copper cup at the end of the bore was very much crushed and distorted in shape, the centre round the vent having been forced forward, while the part near the circumference was crushed back. The breech plug had shifted round 1.1 of an inch, which caused it to project about .02 of an inch to the rear.

The greatest expansion in the bore of this gun after having fired 3,000 rounds was under .05 of an inch, at 21 inches from the bottom.

After the muzzle-loading Armstrong gun had been fired 3,000 rounds, considerable fissures had been formed in the bore, and more particularly in the grooves, the driving edges of which were very much worn; the bore was also much scored, and the steel had an extensive crack in it 20 inches long, extending from the bottom of the bore towards the muzzle through the vent, parallel with the axis of the gun.

The breech screw had not shifted. The greatest expansion of the bore did not amount to .02 of an inch, but there were two indentations in the bore, one .06 in depth at 22 inches from the bottom, and the other .045 in depth at 30 inches.

Subsequently to the practice above recorded with the various guns, which had extended to 3,030 rounds from each, the Committee instituted a series of experiments to break them up by violent disruption with a view to observing the manner of their rupture, and whether they gave any indications such as might be observed in the ordinary use of guns previous to bursting. The strength of all three guns, however, was so great that the ammunition was exhausted without their bursting; the Committee proceed to detail the experiments, which consisted in firing a number of rounds with different charges of powder and weights of projectiles, and with air spaces between the powder and projectiles.



## BREECH-LOADING ARMSTRONG GUN.

| No. of Rounds. | Charge.    |         | Length of Air Space. | Projectiles. |              |         | Recoil.     | REMARKS.                                                                                                                                                                                                                                                                                                                                                         |
|----------------|------------|---------|----------------------|--------------|--------------|---------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | Length.    | Weight. |                      | No.          | Length.      | Weight. |             |                                                                                                                                                                                                                                                                                                                                                                  |
| 10             | inches. 12 | lbs. 9  | inches. 12           | 1            | inches. 7.75 | lbs. 62 | ft. in. 9 5 | Upon examination of the gun after these experiments, a slight crack was perceptible in the powder chamber; the scoring at junction of powder and shot chambers was slightly increased; the exterior crack in the chase was not increased; the expansion of the bore was exceedingly slight, .003 inch, in the powder chamber, and .001 inch in the shot chamber. |
| 20             | " "        | " "     | " "                  | 2            | 15.5         | 124     | 12 7        |                                                                                                                                                                                                                                                                                                                                                                  |
| 20             | " "        | " "     | " "                  | 4            | 31.0         | 248     | 21 10       |                                                                                                                                                                                                                                                                                                                                                                  |
| 10             | " "        | " "     | " "                  | 7            | 54.25        | 434     | 26 9        |                                                                                                                                                                                                                                                                                                                                                                  |
| 1              | 15         | 13½     | 6                    | 5            | 38.75        | 310     | 38 1        |                                                                                                                                                                                                                                                                                                                                                                  |
| 1              | " "        | " "     | " "                  | 6            | 46.5         | 372     | 44 9        |                                                                                                                                                                                                                                                                                                                                                                  |
| 2              | " "        | " "     | " "                  | 7            | 54.25        | 434     | 50 2        |                                                                                                                                                                                                                                                                                                                                                                  |
| 1              | " "        | " "     | " "                  | 10           | 69.75        | 740     | 60 0        |                                                                                                                                                                                                                                                                                                                                                                  |
| 2              | 12         | 9       | None                 | 1            | 7.75         | 62      | 8 1         |                                                                                                                                                                                                                                                                                                                                                                  |
| 1              | 15         | 13½     | 6                    | 5            | 80.60        | 640     | 60 0        |                                                                                                                                                                                                                                                                                                                                                                  |
| 20             | " "        | " "     | " "                  | 4            | 56.11        | 446     | 38 6        |                                                                                                                                                                                                                                                                                                                                                                  |
| 14             | " "        | " "     | 12                   | 3            | 48.36        | 384     | 30 9        |                                                                                                                                                                                                                                                                                                                                                                  |
| 102            |            |         |                      |              |              |         |             |                                                                                                                                                                                                                                                                                                                                                                  |

## WHITWORTH GUN.

| No. of Rounds. | Charge.      |         | Length of Air Space. | Projectiles. |            |         | Recoil.      | REMARKS.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------|--------------|---------|----------------------|--------------|------------|---------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | Length.      | Weight. |                      | No.          | Length.    | Weight. |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 10             | inches. 14.5 | lbs. 10 | inches. 12           | 1            | inches. 12 | lbs. 61 | ft. in. 8 11 | At 73rd round the chase shifted forward .08 inch. After the firing the hoop in rear of the trunnion ring was split through longitudinally, its whole length, in two places over the point of largest expansion in the bore. Fissures and scoring in bore considerably increased, extending 56 inches from the bottom of the bore in each angle of the rifling, the deepest of the fissures .3 of an inch deep. Distortion of cup much increased. The barrel and hoop over the chase shifted forward .2 inch, but whether this is due to elongation of barrel, or to fracture in rear of cup cannot be ascertained without removal of breech screw; there is no apparent fracture in the barrel itself. Expansion of bore much developed during this practice, the greatest being .299 inch at 33 inches from the bottom of the bore. The movement previously reported in the breech screw has not increased it has turned 1.1 inch, and projects .02 inch. |
| 20             | " "          | " "     | " "                  | 2            | 24         | 122     | 11 8         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 20             | " "          | " "     | " "                  | 4            | 48         | 244     | 16 4         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 10             | " "          | " "     | " "                  | 7            | 84         | 427     | 25 2         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 1              | 21.0         | 15      | 6                    | 5            | 60         | 305     | 31 5         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 1              | " "          | " "     | " "                  | 6            | 72         | 366     | 33 9         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 3              | " "          | " "     | " "                  | 7            | 84         | 427     | 39 10        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 2              | 14.5         | 10      | None.                | 1            | 13.75      | 69      | 7 5          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 21             | 21.0         | 15      | 6                    | 6            | 82.50      | 414     | 30 10½       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 14             | " "          | " "     | 12                   | 6            | 82.50      | 414     | 30 10        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 102            |              |         |                      |              |            |         |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

## MUZZLE-LOADING ARMSTRONG GUN.

| No. of Rounds. | Charge.      |         | Length of Air Space. | Projectiles. |              |            | Recoil.     | REMARKS.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------|--------------|---------|----------------------|--------------|--------------|------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | Length.      | Weight. |                      | No.          | Length.      | Weight.    |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 10             | inches. 10.1 | lbs. 10 | inches. 12           | 1            | inches. 8.25 | lbs. 61.75 | ft. in. 9 8 | The top coil shifted .01 inch at the 87th round. The steel barrel is split longitudinally in four places, from bottom of bore, 21 inches on the upper side through the vent, 24 inches along one groove, 24½ inches along another groove, and 25 inches along a third groove, besides two slight cracks under an inch in length, and two slight cracks at 26 inches from bottom of bore transversely to the axis. The scoring in bore has slightly increased, and the joint in rear of trunnion hoop has opened .01 of an inch. The greatest expansion of the bore is .08 inch at 21 inches from bottom of bore. |
| 20             | " "          | " "     | " "                  | 2            | 16.5         | 123.5      | 12 9        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 20             | " "          | " "     | " "                  | 4            | 33.0         | 247.0      | 22 4        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 10             | " "          | " "     | " "                  | 7            | 57.75        | 432.25     | 26 7        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 1              | 18.0         | 15      | 6                    | 5            | 41.25        | 308.75     | 31 5        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 1              | " "          | " "     | " "                  | 6            | 49.5         | 370.5      | 34 1        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 2              | " "          | " "     | " "                  | 7            | 57.75        | 432.25     | 41 6        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 1              | " "          | " "     | " "                  | 10           | 82.5         | 617.5      | 48 8        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 2              | 12.1         | 10      | None.                | 1            | 8.25         | 61.75      | 8 11        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 1              | 18.0         | 15      | 6                    | 10           | 82.5         | 617.5      | 60 0        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 20             | " "          | " "     | " "                  | 7            | 57.75        | 432.25     | 38 6        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 14             | " "          | " "     | 12                   | 6            | 49.5         | 370.5      | 30 9        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 102            |              |         |                      |              |              |            |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

From the experiments detailed in the above tables, it appears that the breech-loading gun, the weight of which is only 96 times that of its projectile, was scarcely injured at all in the bore or in the body of the gun.

In the Whitworth gun, the weight of which is 124·6 times that of its projectile, the bore was much expanded, but the barrel was not otherwise apparently injured, whilst the outer coil over the reinforce was seriously cracked, so much so as to be almost in pieces, and some movement had taken place longitudinally between the barrel and hoops, the nature of which cannot be ascertained until the gun is taken to pieces.

In the muzzle-loading Armstrong gun, the weight of which is 121·6 times that of its projectile, the steel barrel at the breech end was almost in pieces, but was held securely together by the super-imposed coils, in which there had been a very slight movement over the breech.

These experiments having been made in guns the dimensions and conditions of which are so very different, cannot be made use of for strict comparison, but they exhibit in a very remarkable manner the extraordinary strength and endurance of all the guns, which is far above that which can ever be necessary from mere motives of safety for guns required for the service of artillery, whether on shore or afloat; and they prove that, if conditions of safety alone be considered, guns might be constructed far lighter than those which have been under trial, and subjected to these very severe trials by the Committee.

The results, however, are calculated to give entire confidence in the use of steel for the barrels of guns, and both in steel and wrought-iron coiled hoops for strengthening those barrels, and from the injury the guns have sustained, it would appear that in each case they would have given evident signs of approaching decay before disruption, sufficient to cause precautionary measures to be taken in firing them.

In order to ascertain the effect of shot striking the guns, one of each was laid on skids and fired at with solid shot from a 40-pounder gun at a distance of 40 yards. The breech-loading gun fired at was that which had a coil and not a steel barrel; the first round struck the gun 20 inches from the muzzle, at an angle of 20°, and made an indentation with a slight bulge in the interior of the gun. The second round struck close to the same spot at an angle of 35°, and broke off three feet from the muzzle of the gun.

The first shot struck the Whitworth gun 38 inches from the muzzle, at an angle of 20°, making an indentation on the front edge of the second hoop. The second shot struck nearly on the same spot, at an angle of 35°, and made an indentation, but otherwise the gun was not injured. The third shot struck nearly full, at an angle of 85°, on the second hoop in front of the trunnion, and started it, but without doing any damage to the gun; this blow was on the same hoop which had been indented by the first shot. At the fourth round the gun, being in the same position, was struck on the chase at a distance of 29 inches from the muzzle; the gun was temporarily disabled, the bore being bulged so that a shot could not be passed down it.

The muzzle-loading Armstrong gun was struck by the first shot at an angle of 20° at a distance of thirty inches from the muzzle, and received an indentation, which however did not damage the gun. The second shot struck close to the point where the first had struck; it made an indentation and cracked the exterior coil, but without injuring the bore. The third shot hit at the junction of two coils in front of the trunnions at an angle of 85°, it cracked the front strengthening coil both longitudinally and transversely and the other coil transversely, but did not injure the bore. The fourth shot struck nearly full at 46 inches from the muzzle, cracked the steel barrel and the first hoop all round, and rendered the gun unserviceable.

With a view to testing the capability of the various descriptions of ammunition to stand the rough usage to which they may be subject on service, the Committee caused a number of shells, fuzes, and lubricators to be travelled two hundred miles in Flanders wagons along the roads in the Royal Arsenal at Woolwich.

The effect upon the Armstrong shells was to bruise the lead of the breech-loading and copper studs of the muzzle-loading projectiles, but not in either case to an extent to affect the ease with which the guns were loaded. The Whitworth shells were not injured.

Thirty rounds of shot also were tested by throwing them into a wagon and then out again in a heap, the operation being repeated twice; none of them were injured so as to affect their ease of loading, but in several cases the hollow heads of the Armstrong shot were broken.

The lubricators of all the systems will evidently not stand ordinary transport by land.

Colonel Boxer's sea service percussion fuze was not travelled. Sir W. Armstrong's pillar fuzes may be travelled bottom up without much injury, but when reversed one-half were injured, one-third being in a dangerous condition.



## X.—SIMPLICITY OF CONSTRUCTION.

The three 70-pounder breech-loading guns supplied by Sir W. Armstrong, for the Committee's experiments, are all built up guns, but differ somewhat from each other, inasmuch as two of them have inner tubes or barrels of steel 1 and  $1\frac{3}{4}$  inches thick respectively, and the third an inner tube of coiled wrought iron. Sir W. Armstrong having preferred that the trials for endurance should be made with the gun which has the thicker tube of steel, the Committee proceed briefly to describe the construction of that gun, as representing the most perfect type of Sir W. Armstrong's breech-loading system which can be produced.

The leading dimensions of this gun are as follows :

|                                                             |   |   |   |                 |
|-------------------------------------------------------------|---|---|---|-----------------|
| Weight of gun                                               | - | - | - | 62.0 cwt.       |
| Ratio of weight of shot to that of gun                      |   |   |   | $\frac{1}{8}$ . |
| Calibre                                                     | - | - | - | 6.4 inches.     |
| Length of bore                                              | - | - | - | 91.92 "         |
| "    gun                                                    | - | - | - | 110.0 "         |
| Diameter at muzzle                                          | - | - | - | 11.9 "          |
| Rifling, 1 turn in 40 calibres;<br>or 1 turn in 256 inches. |   |   |   |                 |
| Thickness of metal at muzzle:                               |   |   |   |                 |
| Steel                                                       | - | - | - | 1.75 "          |
| Coiled wrought iron                                         | - | - | - | 1.00 "          |
| Total                                                       | - | - | - | 2.75            |
| Diameter at breech                                          | - | - | - | 24.2 inches.    |
| Calibre of chamber                                          | - | - | - | 6.63 "          |
| Thickness of metal at breech:                               |   |   |   |                 |
| Steel                                                       | - | - | - | 2.15 "          |
| Wrought iron                                                | - | - | - | 4.80 "          |
| Coiled wrought iron                                         | - | - | - | 1.85 "          |
| Total                                                       | - | - | - | 8.80            |

The steel inner tube or barrel extends throughout the whole length of the bore in one piece, but is not continued in rear of it. This tube has been described to the Committee as made originally in the form of a solid ingot, by one of the largest and best manufacturers of steel, with whom it is specified that a certain length of dead head, which varies with the size of the gun, is to be cut off; the ingot is then drawn under the hammer, after which discs are cut from each end, and a small rectangular test bar from each disc. Each of these test bars being then supported between two bearing surfaces, has a weight dropped upon it, the proof of its toughness being the angle to which it is required to bend, and which is different according to the size of the gun, and the proof of its hardness being the number of blows it takes to bend it to that angle.

This test process is performed with the pieces cut from both ends of the ingot, after which, if passed, the ingot is bored; it is then very carefully examined for flaws, and if no flaw appear, the boring is finished with a very fine polish; it is then left for two or three days and examined again, when if there should be any small cracks or flaws in the steel, which would not ordinarily be visible, they become apparent; after this final examination, if found right, the barrel is passed. Simultaneously with the boring it is turned parallel externally, but thicker at the reinforce than along the chase of the gun. In the case of the 70-pounders and all other moderately sized guns, the barrels are tempered in oil, a process which is not applied, nor indeed recommended, by Sir W. Armstrong for large masses of steel.

When the barrel is completed a carefully turned tube consisting of coils over the chase, jump-welded to a wrought-iron breech piece, intended to convey the strain caused by the explosion of the powder longitudinally from the breech to the trunnions, is shrunk on over the steel barrel, through which a stream of water is kept running during the operation to keep down its temperature. Five other hoops, including that which carries the trunnions, and which is made of wrought iron, are subsequently shrunk on to complete the body of the gun, which it is thus seen consists of eight distinct parts held together by the compression brought upon them by shrinking one on over the other in their respective positions, some additional strength being obtained in a longitudinal direction

by jump-welding the joints of the first tube before shrinking it on. The whole of the tubes before being built into the gun are turned cylindrically, both inside and out, to regulate and insure an uniformity of strain through the various parts of the same tube.

To the gun so made, the side wedge loading machinery has to be added, consisting of the cupholder and supporting wedge, with the contrivance for preventing the vent, which is in the usual place, at a certain distance from the end of the bore, from being primed until the breech-loading apparatus is in its place. A shallow tin cup, which is issued with the ammunition in the proportion of one to each round, but which the Committee ascertained by experiment may be used without changing for a considerable number of rounds (one was used for 26 rounds), also forms part of the breech-loading apparatus; it is formed of very strong block tin, is about half-an-inch in depth, and is attached in front of the cupholder, by which, when the breech-loading apparatus is closed, it is forced up into the bore to prevent the escape of gas.

The breech-loading gun is necessarily chambered, the bore being formed with a shoulder at the commencement of the many grooved rifling, against which the lead-coated projectile jams home when thrust from the rear of the gun into the "bullet chamber," which is made rather larger than the remainder of the bore to receive it.

The leading dimensions of Mr. Whitworth's 70-pr. gun are as follows:—

|                                        |                                                                |                           |
|----------------------------------------|----------------------------------------------------------------|---------------------------|
| Weight of gun                          | -                                                              | 78 cwt.                   |
| Ratio of weight of shot to that of gun | -                                                              | $\frac{1}{12\frac{1}{4}}$ |
| Calibre, major axis                    | -                                                              | 5.53 in.                  |
| " minor do.                            | -                                                              | 5.03                      |
| Length of bore                         | -                                                              | 108.0                     |
| " of gun                               | -                                                              | 118.40                    |
| Diameter at muzzle                     | -                                                              | 11.3                      |
| Rifling, 1 turn in                     | $\left\{ \begin{array}{l} 18.08 \\ 20.02 \end{array} \right\}$ | *calibres;                |
| or                                     | 1 turn in                                                      | 100 inches.               |
| Least thickness of metal at muzzle     | -                                                              | 2.89                      |
| Extreme diameter at breech             | -                                                              | 24.75                     |
| Least thickness of metal at do.        | -                                                              | 9.61                      |

Mr. Whitworth's guns, like Sir W. Armstrong's, are all built up by superimposing tubes, one over the other, to obtain the required strength: the tubes, however, are all of homogeneous metal or mild steel. The metal of which they are made is supplied to Mr. Whitworth by the trade. After receiving the ingots Mr. Whitworth first cuts off a test piece from the breech end of each, a portion of which is turned and bored cylindrically, and hardened and tempered experimentally by heating and immersion in oil, as a guide by which to determine the precise process to be applied afterwards to each ingot. The degree of temper in this test-piece is proved by a gunpowder test, the results of which on a large number of pieces were shown to the Committee. As the strain produced by this test is similar in nature to that to which a gun is subjected in firing, it affords a very satisfactory proof of the metal in the trial piece, which Mr. Whitworth states, is sometimes improved as much as 50 per cent. in strength by the process of tempering.

While these experiments are being made with the trial piece, the ingot of which the barrel is made is turned from end to end, and rough bored cylindrically; it is then hardened and tempered according to the process which has been found to give the required results with the trial piece; it is then turned again on the outside, and the boring and rifling are finished, when, if approved, it is strengthened by external hoops and made into a gun. Mr. Whitworth, however, adopts the plan of turning the outside of his barrel into the form of a frustum of a cone, the sides of which are inclined to the axis at the rate of 1 in 100; the superimposed hoop, which is similarly coned, is then placed over it and forced on by hydraulic pressure to a certain distance beyond the point at which it is an exact fit, the distance through which it is forced forward regulating the strain which is brought upon the metal. Additional hoops are forced on in a similar manner, until the required strength is obtained. These hoops have all originally been cast on cores and hammered on mandrils, after which the process of hardening and tempering has been performed, as described above for the barrels, in each case according to the results obtained experimentally with a test piece. Mr. Whitworth makes each hoop of an equal thickness throughout, except on the outside of the gun when they vary a little for the sake of appearance, so that the longitudinal joints are all parallel from end to end of the

\* The two numbers denote the ratios of rifling to the major and minor axes of the bore.



gun; they are not always, however, in one piece, but, where considered necessary, the different pieces of the same hoop are joined together by screws before being forced on.

The breech of the gun is closed by a breech screw, formed of two screws of the same pitch on the same piece of homogeneous metal, but having different diameters; the smaller one corresponding with the inside of the barrel, the larger with the bore of the first hoop, which envelopes the barrel. This breech screw is thus screwed simultaneously into the barrel, and into the hoop enclosing it; a copper cup is inserted at the bottom of the bore, in front of the breech screw, to protect it from the action of the gas generated by the explosion of the powder. The vent is in the axis of the piece, a cup being placed in the button of the cascable to catch the tubes as they fly out when the gun is fired.

Mr. Whitworth's 70-pounder gun consists then of the barrel and three superimposed hoops. The barrel is in one piece; the first hoop is in three pieces, two of which have been joined by screws previous to being forced on over the barrel; the second hoop is also in three portions, the centre of which carries the trunnions, and is connected by a screw with the piece in rear of it; the third hoop is of a short length in one piece extending over the chamber of the gun. The body of the gun, therefore, consists of eight tubular pieces and the breech screw, all of the same homogeneous metal.

The leading dimensions of the muzzle-loading Armstrong or shunt gun are as follows:—

|                                                            |   |   |                            |
|------------------------------------------------------------|---|---|----------------------------|
| Weight of gun                                              | - | - | 76 cwt.                    |
| Ratio of weight of shot to that of gun                     | - | - | $\frac{1}{121\frac{1}{6}}$ |
| Calibre                                                    | - | - | 6·4 inches.                |
| Length of bore                                             | - | - | 108 "                      |
| Do. gun                                                    | - | - | 123·5 "                    |
| Diameter at muzzle                                         | - | - | 12·4 "                     |
| Rifling 1 turn in 40 calibres;<br>or 1 turn in 256 inches. |   |   |                            |
| Thickness of metal at muzzle:                              |   |   |                            |
| Steel                                                      | - | - | 2·0 "                      |
| Coiled wrought iron                                        | - | - | 1·0 "                      |
| Total                                                      | - | - | 3·0 "                      |
| Depth of groove                                            | - | - | 0·05                       |
| Least thickness of metal at muzzle                         | - | - | 2·95                       |
| Extreme diameter at breech                                 | - | - | 24·2 inches.               |
| Thickness of metal at breech:                              |   |   |                            |
| Steel                                                      | - | - | 2·0 "                      |
| Wrought iron                                               | - | - | 3·0 "                      |
| Coiled wrought iron                                        | - | - | 3·9 "                      |
| Total                                                      | - | - | 8·9 "                      |
| Depth of grooves                                           | - | - | 0·05                       |
| Least thickness of metal at breech                         | - | - | 8·85                       |

This gun, like the other competitive guns on Sir W. Armstrong's breech-loading and Mr. Whitworth's systems, is a built-up gun; it has a steel inner tube or barrel, two inches in thickness, extending a short distance in rear of the bottom of the bore; this steel barrel, which is made and proved similarly to that of the breech-loading gun, is enveloped along the chase by a coiled tube, and thence to the breech by a tube of piled wrought iron, called the breech piece, into which the breech screw is driven. A coiled tube is then shrunk on over the joint of the coil and breech piece in the first tube, and is turned so that its outer surface is even with that of the breech piece, which therefore corresponds in thickness with the two first coils on the chase of the gun. A hoop, consisting of four pieces, including that which carries the trunnion, is then shrunk on, and then another hoop, consisting of two pieces, over the reinforce. The whole of the hoops, with the exception of the breech piece, and that which carries the trunnions, are of coiled wrought iron, and have been turned both on the inside and out, and then shrunk on hot, a stream of water being kept flowing through the barrel during the operation.

Into the rear of the gun so formed a wrought-iron breech screw, corresponding in diameter with the breech piece, is driven, having a steel plug in front of it to close the barrel, with a copper disc between it and the plug, and an iron disc to support the

copper disc, with an annular space round it from which there is an outlet to permit of the escape of any gas which might insinuate itself round the sides of the steel plug and past the copper disc.

The vent is in the usual place, at a short distance from the bottom of the chamber, the length of which is determined by the termination of the rifling, which fixes the point beyond which the shot cannot be driven.

Sir W. Armstrong's muzzle-loading or shunt gun may be said then to consist of the barrel and three superimposed hoops; the barrel is of steel, in one piece; the first hoop is in three pieces, one of which is of wrought iron not coiled, but which has been piled so that the fibre runs longitudinally along the gun, and the other two are of coiled iron; the second hoop is in four pieces, one of which is of wrought iron, and carries the trunnions; the third hoop is in two pieces, extending over the reinforce of the gun. The body of the gun therefore consists of ten tubular pieces and the breech screw, and is made up of metal in three different forms, steel, coiled wrought iron, and common piled wrought iron.

From the description which has been given of the construction of the guns of the three different systems, it will be seen that both Sir W. Armstrong and Mr. Whitworth agree in building up all their guns in preference to making them of one solid piece, and that both employ steel barrels.

The three systems differ as to their mode of rifling, but on this subject the Committee have to report that they are of opinion that, considering the perfection with which tools are made in the present day, and the skill with which they are applied, the mode of rifling is practically nearly on an equality, so far as relates to the simplicity of construction of the gun, and can make but little difference either in the time or cost of production, if the manufacture of the guns were systematically established with a view to producing them rifled on either plan.

The muzzle and breech loading guns proposed by Sir W. Armstrong are both built upon the same principle, with the exception of the method of closing the breech. The Committee have to report that they consider the wedge system of closing the breech much less simple in its construction than the fixed breech of either of the muzzle-loaders, and it has moreover the defect of entailing the employment of a tin cup to prevent the escape of gas, and also of a lubricator between the cartridge and projectile; both of these articles, by complicating the stores requisite to maintain the efficiency of the gun, would add to the difficulty, already very great, of keeping up supplies on service; it has also been found that the tin cup does not preclude the necessity, after a large number of rounds, for inserting a bouch ring in the rear end of the bore where the cupholder comes against it; this is an operation of a delicate nature, requiring complicated tools and a skilled artificer to effect it.

The great differences between Sir W. Armstrong's and Mr. Whitworth's systems of building up their respective muzzle-loading guns are,—

1st. In the use of coiled and piled wrought iron by Sir W. Armstrong *versus* steel by Mr. Whitworth in the hoops which are super-imposed to strengthen the barrels.

2nd. In the method of superimposing the hoops, whether by shrinking them on hot, as practised by Sir W. Armstrong, or forcing them on cold, as practised by Mr. Whitworth.

3rd. In the methods of closing the breech.

1st. As to the use of coiled and piled wrought iron or steel in the super-imposed hoops.

It is well known that wrought iron is capable of sustaining a greater tensile strain in the direction of its fibre than transversely to it; the object, therefore, in coiling the iron spirally round the barrel is that the rending effect of the charge within the bore may be resisted by the action of the iron in the direction of its length. When each coil has been rolled, the spirals are welded together by hammering on the ends of the coils; but as all welds are more or less imperfect, it is evident that the coil has much less power to resist a tensile strain in the direction of its length than transversely. Mr. Anderson, the Assistant Superintendent of the Royal Gun Factory, who has had large experience in the manufacture of coiled guns, informed the Committee that the strength of the coils, which sometimes comes up to 26 tons on a square inch in the direction of their circumference, only averages from 10 to 14 tons longitudinally; and Captain Noble, a partner in the Elswick Ordnance Company, who was examined before the Committee on the part of Sir W. Armstrong, stated that iron welded has only 50 or 60 per cent. of the strength of the original bar.

On account of this deficiency of strength Sir W. Armstrong has thought it necessary to insert within the outer coils a very strong breech-piece, extending from the chase to



the breech. This breech-piece is welded up with the fibre in the direction of the length of the gun, and holds the breech-screw so that the strain caused by the action of the powder on the bottom of the bore is transmitted through this breech-piece to the trunnions, this arrangement apparently answers perfectly the purpose for which it is intended, viz. preventing a strain in a longitudinal direction which the coils are less calculated to support.

Mr. Whitworth adopts a mild steel which he considers homogeneous and as possessing greater strength than wrought-iron in any direction, and equal power of resisting a tensile strain in every direction, and builds up his gun entirely of this material.

On the question of the power of steel to withstand the strains to which it is subject when applied in the construction of guns, the Committee desire to point out that at the commencement of their inquiry, Sir W. Armstrong did not consider that the manufacture of steel had made such progress, that he could make even the barrels of guns of this metal, although he at that time (January 1863) fully appreciated its great advantages when so applied; but that now, after a lapse of two years, the difficulties in its manufacture have been so far overcome, and his confidence in it so far established, that he is making and supplying 600-pounder guns of 12.5 inches calibre with steel barrels. The trials of the guns which have been experimented with by the Committee have been of a nature, so far as they have gone, to give every confidence in the employment of steel in the barrels of guns, and especially has this been the case with the breech-loading Armstrong gun, the steel inner tube or barrel of which received no material injury, though its strengthening coils were cracked across, by the shot having passed over an obstruction in the bore.

On this subject the Committee desire particularly to direct attention to the evidence of Mr. Whitworth, who stated that the great uncertainty in the steel delivered to him by the manufacturers had been most unsatisfactory; that he therefore tempers each separate piece used in building up his guns according to its nature, as determined experimentally by test pieces and the powder proofs applied to them; that the metal is sometimes improved 50 per cent. in strength by tempering, and is from two to three times as strong as the best wrought iron, and that when so prepared and carefully examined, he has perfect confidence in it for all parts of his guns.

The Committee have also to draw attention to the experiments made to ascertain the effect of shot striking the guns, from which it appeared that the greater strength of the steel, and its uniformity in every direction, give it more power to resist the force of impact of shot than the coils, which are more liable to break transversely to the axis of the gun in the direction of the coil.

The Committee desire further to point out that steel is being largely introduced in engineering works of the greatest importance, and where the most perfect uniformity in strength is required when subject to continually recurring strains, such, for instance, as occur in rails and locomotives for railways, in shafts and axles for machinery, in ship building, and for numerous purposes where lightness is required in combination with great strength, hardness, and durability, and therefore it may be expected that the manufacture will be greatly extended and improved, and that the metal itself will become more uniform in quality.

On the whole the Committee consider that the trials with Mr. Whitworth's guns, which are composed entirely of steel, and the experience gained with the steel barrels of Sir W. Armstrong's guns, have proved that steel may now be produced capable of standing all the strains, of whatever character they may be, which are brought upon the metal of which guns, at least up to the calibres of those tested by the Committee, are constructed, and they have every reason to believe that with a careful system such as that adopted by Mr. Whitworth of testing and tempering each separate piece that enters into the constitution of a gun, perfect confidence in the safety of steel built-up guns may eventually be established. The Committee, however, add that the defective manufacture of a gun composed entirely of steel would probably be attended with more serious consequences than if constructed with a steel barrel and super-imposed coils.

2nd. As to the method of superimposing the hoops, whether by shrinking them on hot or by forcing them on cold by hydraulic pressure.

The Committee were desirous of obtaining information as to the effect produced by placing massive coils which have been raised for the purposes of expansion to a very high temperature over steel. Capt. Noble considered that this operation might have some effect on the temper of the steel, but not to a great extent, and stated that he had had barrels taken out of their coils and tested, and that there was no material difference in them. This would appear to be borne out by the soundness of the guns which have been experimented upon; but at the same time it is a subject upon which it is very desirable that some special experiments should be made.

It was stated to the Committee that there is a risk of the barrel turning round within the hoops when forced on cold by pressure, but the trials of the experimental guns, and the experience of the Royal Gun Factory on this point, appear satisfactory. The Committee have it in evidence that in relining old guns in the Royal Gun Factory, when the gun cannot be warmed, the hydraulic press is always used to push the barrels in, and that there had been no complaints of their moving. Mr. Whitworth attaches importance to this mode of placing on the hoops, as requiring greater care on the part of the workmen, with respect to their sizes, and as ensuring that every part of the metal takes up the same strain.

The Committee having witnessed both operations, have to report that there is no difficulty in placing the hoops on in either way, that the difference of expense, if the manufacture were established, would not be very great; that there has been no appearance of any movement of the inner lining within the hoops of either of the guns experimented with by them, notwithstanding their twist, and the great number of rounds which have been fired, and they agree with Mr. Whitworth that the method of forcing the hoops on cold is the better of the two. It is to be observed, however, that when steel hoops are used the method of shrinking them on hot cannot be applied, but recourse must be had to a system of forcing them on cold, as adopted by Mr. Whitworth.

3rd. As to the method of closing the breech.

The guns not having broken up, notwithstanding the very extraordinary powder tests to which they have been submitted, the Committee have not been able to ascertain the effects produced upon the methods adopted by Sir William Armstrong and Mr. Whitworth for closing the breeches of their respective muzzle-loading guns, and they, therefore, recommend that these guns should be taken to pieces and carefully examined, and that the manufacturers be communicated with as to the mode in which the guns should be taken to pieces.

Another point remains to be considered, in which there has been a difference in construction between the muzzle-loading guns of the two inventors.

Mr. Whitworth, as has been stated in a previous part of this report, placed his vent in the axis of the gun, so as to ignite the charge from the rear instead of on top. It was found that when the ignition took place from the rear with a cartridge made up in the ordinary manner, the gun lost considerably in range. Mr. Whitworth was therefore led to adopt a cartridge having a leather paper tube, with quick-match in it, inserted up the charge from the rear, so as to ignite it in its centre, when he obtained the same ranges as he had previously done from the top vent.

The Committee, however, have to report that, fully recognizing the mechanical advantage gained by not piercing, and thus weakening, the body of the gun for a vent in the usual manner, they are of opinion that the rear vent is rather more difficult to serve, and is more liable to foul, and that the complication caused by the introduction of the tube in the cartridge is a great objection to its adoption.

Having fired a great number of rounds from the top vent at the commencement of their experiments, as explained in a previous part of their report, the Committee have compared the results thus obtained with those obtained by firing from the rear vent with the special cartridges of the same weight.

The following are the results deduced similarly to those before stated, while treating of range:—

| Elevation.      | Whitworth Gun, Top Vent,<br>Charge, 10 lbs. |                |                             | Whitworth Gun, Rear Vent,<br>Charge, 10 lbs. |                |                              | Relative Accuracy. |            |
|-----------------|---------------------------------------------|----------------|-----------------------------|----------------------------------------------|----------------|------------------------------|--------------------|------------|
|                 | No. of<br>Rounds.                           | Mean<br>Range. | Mean<br>Radial<br>Distance. | No. of<br>Rounds.                            | Mean<br>Range. | Mean<br>Radial<br>Distances. | Top Vent.          | Rear Vent. |
| SOLID SHOT.     |                                             |                |                             |                                              |                |                              |                    |            |
| °               |                                             | Yards.         | Inches.                     |                                              | Yards.         | Inches.                      |                    |            |
| 0               | 30                                          | 483            | 8                           | 20                                           | 506            | 21                           | 1                  | 2·6        |
| 3               | 21                                          | 1,753          | 48                          | 30                                           | 1,761          | 96                           | 1                  | 2          |
| 6               | 30                                          | 2,975          | 99                          | 40                                           | 2,948          | 156                          | 1                  | 1·6        |
| 6               | —                                           | —              | —                           | 30                                           | 2,922          | 211                          | 1                  | 2·1        |
| 9               | 36                                          | 4,029          | 142                         | 25                                           | 4,051          | 371                          | 1                  | 2·6        |
| SHRAPNEL SHELL. |                                             |                |                             |                                              |                |                              |                    |            |
| 2               | 40                                          | 1,371          | 36                          | 30                                           | 1,355          | 80                           | 1                  | 2·2        |
| 5               | 40                                          | 2,625          | 102                         | 16                                           | 2,557          | 99                           | 1                  | 1·0        |



These results are sufficiently remarkable, as showing that the range of the gun when fired from the two vents was almost identical, but that the gun on a mean of 197 rounds, fired at different elevations has been almost uniformly twice as accurate when fired from the top vent as when fired from the rear vent.

It must here be remarked that the practice with the top vent was carried on in July, whereas that with the rear vent took place in November, thus giving a certain advantage to the practice with the top vent; the Committee recognize this, but as the state of the weather was not at all abnormal at either period, they do not consider that this is sufficient to account for the above-mentioned great disparity in accuracy.

The Committee do not attempt to explain this fact, but merely to direct attention to it as tending to confirm their opinion that the rear vent is objectionable, and that the top vent, as applied in Sir W. Armstrong's gun, is superior for all practical purposes, and they regret they have had no opportunity of testing the endurance of Mr. Whitworth's gun when fired from the top vent.

#### XI.—COMPARATIVE COST, SO FAR AS CAN BE ASCERTAINED, BEFORE THE MANUFACTURE HAS BEEN SYSTEMATICALLY ESTABLISHED.

The Committee have visited the Elswick Gun Factory, and that of the Manchester Ordnance Company, and have witnessed the various processes by which both guns and projectiles are manufactured; they have also taken evidence, and have endeavoured to collect such information as will permit of a judgment being formed on this most difficult question on such grounds as will not lead to any very material error, if the manufacture on either of the respective systems were established and pursued on a large scale for the supply of the whole artillery service of the country.

The Committee consider that if a factory were established on such a scale as that contemplated, the difference in the prime cost of machinery, and in its maintenance and repair, might for the purposes of this inquiry be neglected, first, because it would probably be comparatively small; and, secondly, because these charges would have to be distributed over so large an area of production as to be virtually of small consequence, if not inappreciable, when subdivided among the number of articles produced. There remain then to be considered only the cost of material and of labour.

1st. With reference to the guns themselves.

Sir W. Armstrong's breech-loading gun is so similar in construction to his muzzle-loading gun, that it will be unnecessary to compare it in respect of cost with the guns of the two muzzle-loading systems, further than to observe that the moveable breech-loading apparatus is more expensive in prime cost than the fixed apparatus in the muzzle-loading guns, and that it entails an expense in the supply of tools for bouching the bore, and a further expense, which is continually recurring, for tin cups for preventing the escape of gas; these cups were supplied to the Committee at 7*l.* 10*s.* per hundred.

With respect to the guns of the muzzle-loading systems, it is to be observed that the inner tubes or barrels, being of the same material, the cost of their manufacture may be considered as about equal, and, therefore, that any difference in the cost of the guns must have reference solely to the hoops, in which are comprised about three-fourths of the total weight of the gun.

With respect to the hoops, it appears from the evidence of Capt. Noble that the coils cost about 30*l.* per ton in their rough state before being turned, and that steel as delivered by the manufacturers in a corresponding state costs from 70*l.* to 130*l.* per ton, according to the size of the mass. Mr. Whitworth stated that the price of steel is from 70*l.* to 90*l.* per ton, and that in consequence of the very great progress which is being made in its manufacture, and the increasing demands for it for engineering purposes, he does not doubt that its price will be very much reduced, and that the price of steel for which 60*l.* are now being paid will before long be reduced to 30*l.* per ton, and that therefore it would not be right to assume that the present price is likely to continue. There can be no doubt, then, that the material steel as cast and hammered into ingots is much more expensive at present than coils of wrought iron in their rough state. Steel, however, in the present stage of development of its manufacture for use in large masses may be considered in much the same relative position as wrought iron when reintroduced a few years ago in the manufacture of artillery; since then the manufacture of wrought iron in large masses has been developed and brought to a high degree of perfection, its progress having been greatly stimulated by the demands for good material of certain and uniform strength for guns and other warlike purposes, and owing to competition, masses, which a few years ago could not have been obtained at any price, as being quite beyond the powers of the then existing machinery to produce, are now manufactured at comparatively moderate cost.

The Committee consider, therefore, that any lengthened inquiry into the question of the precise relative cost of steel and wrought-iron hoops for guns would at the present time be only apt to mislead, as they look forward to the time, probably not very far distant, when the production of steel for such purposes as the manufacture of guns will be most materially cheapened. This reduction in the price of steel will, however, probably be simultaneous with a considerable reduction in that of coiled wrought iron.

As to that part of the cost of the guns which is due to workmanship, the Committee have to report that the expense of making the barrels, including their rifling, may be considered in both cases as practically equal, that is supposing the manufacture of the guns were systematically established with a view to producing them rifled on either system; and that both Mr. Whitworth and Capt. Noble are agreed that there would not be any very great difference in the cost of building up their respective guns. Although, therefore, the labour in preparing the steel hoops for a gun is greater than that required to prepare the coils, and consequently the construction of guns with steel hoops is somewhat more costly, the Committee are of opinion that the difference in the cost of workmanship in building up guns on the two systems is comparatively small and need not be taken into account in considering this question, which therefore will be seen to rest almost entirely on the difference in the cost of production of the rough materials, which in the form of hoops constitute about three-fourths of the entire weight of the gun.

The prices of the 70-pr. guns supplied to the Committee in 1863-64 are as follows :—

|                          |   |   |     |
|--------------------------|---|---|-----|
|                          |   |   | £   |
| Breech-loading Armstrong | - | - | 692 |
| Whitworth                | - | - | 710 |
| Muzzle-loading Armstrong | - | - | 543 |

As illustrative of the cost of guns at the present time, the Committee append an abstract compiled from statements which have been furnished by Sir W. Armstrong and Mr. Whitworth, of the actual prices at which they are now supplying their respective guns. These prices might, however, without doubt, be considerably reduced if the guns were supplied in large numbers. In this abstract guns only are shown which nearly correspond in the weight of their projectiles.

| M. L. Armstrong. |   |   |                   | Whitworth.       |   |   |        |
|------------------|---|---|-------------------|------------------|---|---|--------|
| 40-prs.          | - | - | from £315 to £385 | 32-prs.          | - | - | £475   |
| 70-prs.          | - | - | „ £550 to £650    | 5½-inch (70-pr.) | - | - | £700   |
| 150-prs.         | - | - | „ £945 to £1,100  | 7-inch (150-pr.) | - | - | £1,350 |

On reviewing the whole question of simplicity of construction combined with cost of the two systems of building up guns of steel barrels, strengthened by wrought-iron coils or entirely of steel, the Committee are of opinion that guns of position, and for siege and naval purposes, may safely be constructed at present on the former plan at much less cost than on the latter.

2nd. With reference to the projectiles.

The projectiles proposed for the various guns have been all detailed in a previous part of this report, on reference to which it will be seen that they do not differ much in weight, and therefore being constructed of the same material (with the exception of the segment and shrapnel shell and case shot), they may be considered as equally costly, so far as relates to the mass of the projectile, and that their ultimate cost differs only in consequence of the material and labour requisite to adapt them for the various systems of rifling.

The Committee have obtained from Sir Wm. Armstrong and Mr. Whitworth a list of prices at which they are actually supplying ammunition for their respective guns, of which the following is an abstract, containing such only as can fairly be compared :—

| M. L. Armstrong. |             |             |   | Whitworth.         |   |          |   |
|------------------|-------------|-------------|---|--------------------|---|----------|---|
| Common Shell.    |             | Per 100.    |   | Common Shell.      |   | Per 100. |   |
| For 12-prs.      | from £12 19 | 2 to £17 10 | 0 | For 12-prs.        | - | £15 0    | 0 |
| „ 40-prs.        | „ 37 10     | 0 to 45 0   | 0 | „ 32-prs.          | - | 37 10    | 0 |
| „ 70-prs.        | „ 60 0      | 0 to 75 0   | 0 | „ 5½-inch (70-pr.) | - | 62 10    | 0 |
| „ 150-prs.       | „ 117 1     | 8 to 150 0  | 0 | „ 7-inch (150-pr.) | - | 115 0    | 0 |



The Committee have to observe, that it would appear that some of the prices quoted above, as those at which the ammunition for the muzzle-loading Armstrong guns have been supplied, are based upon the studs being made of a material different from that with which all their experiments have been made. From a statement forwarded to the Committee by Sir W. Armstrong it appears that by the employment of this material, which is rolled zinc, the cost of fitting the 12-pounder shell with studs is reduced from 19s. 4d. to 9s. 10d. per hundred, or about one half; and Sir W. Armstrong considers that even this price is high, and may be reduced when a more perfect process shall have been adopted for converting the material into the form of studs. The only opportunity the Committee have had of seeing these studs tried was near the conclusion of their experiments, when at Sir W. Armstrong's request, 25 rounds of long common shell were fired; several of these rode out of the grooves, indicating that the metal was too soft when taken in connexion with the extent of surface in those studs to withstand the friction against the grooves to which they were exposed.

With such little experience of this cheaper material the Committee do not feel themselves in a position to state whether studs composed of it would answer equally well on service as copper studs; they therefore consider that the comparison should be made on calculations based on the employment of copper studs.

The Committee, having witnessed the manufacture of the projectiles on the various systems, are of opinion that, so far as relates to their adaptation for the various systems of rifling, the lead-coated projectile of the breech-loading gun is by far the most expensive, and the least calculated to resist the rough usage to which it must be subject on service. They are also of opinion that the cost of the workmanship bestowed upon the bodies of the projectiles of the two muzzle-loading systems does not differ very materially, and the expense of the material and labour used in making the studs for the muzzle-loading Armstrong projectiles represents approximately the excess of their cost over and above that of the Whitworth projectiles.

The actual (contract and piece work) cost of the material in the copper studs, and of the labour in putting them into the 12-pounder shell, is stated by Sir W. Armstrong to be 17s. 8½d. per 100 shells, a price which is far less than that given by the Superintendent of the Royal Laboratory. Whatever the price may be, it may be assumed to increase with different calibres nearly in proportion to the respective weights of the projectiles, and, taking the price given by Sir W. Armstrong, the cost of copper studs for the 70-pounder would amount to about 5l. per hundred projectiles; if zinc studs were used the cost would be reduced about one-half.

If the immense supplies of ammunition for all descriptions of artillery for all military and naval purposes be considered, this difference in the expense of the projectiles will form an item for consideration in determining the nature of rifling to be adopted.

The Committee do not propose to go into the question of the relative cost of the segment shell and case shot, proposed by Sir W. Armstrong, as opposed to the shrapnel shell proposed by Col. Boxer, and Mr. Whitworth's case shot, as they are of opinion that the effects of the two latter, as previously reported by them, are so superior that whichever system of rifling may be preferred there can be no hesitation as to the propriety of adopting the principles involved in the construction of these projectiles, apart from the guns for which they have been specially submitted to the Committee.

As regards steel shot and shell the Committee consider that there will be comparatively very little difference in the expense of their production for the various guns, the cost of rifling being very small in comparison with that of the steel in the projectiles.

## XII.—FUZES.

The Committee tested the time fuzes, proposed by Sir W. Armstrong and Colonel Boxer, R.A., by firing twenty rounds from each gun at elevations of 3°, 4°, and 5°. The mean differences in the times of their burning were as follow:—

|                                             |   |                                     |
|---------------------------------------------|---|-------------------------------------|
| Sir W. Armstrong's time fuze fired from the | } | .05 seconds, with five blind fuzes. |
| breech-loading gun                          |   |                                     |
| Colonel Boxer's time fuze fired from Mr.    | } | .12 seconds, with one blind fuze.   |
| Whitworth's gun                             |   |                                     |
| Sir W. Armstrong's time fuze fired from     | } | .10 seconds, with two blind fuzes.  |
| muzzle-loading gun                          |   |                                     |

The regularity of the burning of all the fuzes was extremely good, and if due allowance be made for the manner in which the experiments were conducted, they may be considered practically equal; but when the number of blind shell is considered, a decided

preference must be given to Colonel Boxer's fuze. They have only therefore to repeat the opinion expressed at page xlii. of their preliminary report, when after maturely considering the experiments then made, the report of the chemist of the War Department, the relative cost of the two fuzes, and having given due weight to certain advantages possessed by Sir W. Armstrong's time fuze, they reported that "Colonel Boxer's time fuzes are superior to and better adapted for the service than Sir W. Armstrong's time fuzes."

They have also to refer to the opinion expressed in their preliminary report with reference to the percussion fuzes proposed by Sir W. Armstrong and Colonel Boxer, with which they have conducted no further experiments since that report was written. They have, however, to observe with reference to the experiments with these fuzes when grazing on water, that the Committee in making them, used Sir W. Armstrong's percussion fuze with the ordinary service plug in front of it instead of an ordinary time fuze or solid plug; the effect of which was that the water rushing through the holes in the plugs may have conduced to the failure of these fuzes.

The Committee also tested Sir W. Armstrong's pillar fuzes and Colonel Boxer's sea service percussion fuzes by firing a number of rounds; 1st, to ascertain whether the detonating arrangements would resist the effect of impact produced by ricochet on water and then act on striking the ordinary scantling of a wooden ship; and 2ndly, whether the detonating arrangements were sufficiently sensitive to cause the fuzes to ignite, and the shells to burst on striking direct against similar objects;

| Nature of Fuze.        | From what Gun fired. | Fired to act on striking after graze. |                 |            |        | Fired to act on striking direct. |            |        |
|------------------------|----------------------|---------------------------------------|-----------------|------------|--------|----------------------------------|------------|--------|
|                        |                      | Good.                                 | Burst on graze. | Premature. | Blind. | Good.                            | Premature. | Blind. |
| Pillar fuze -          | B.L. Armstrong -     | 12                                    | 1               | 0          | 0      | 26                               | 0          | 1      |
| Colonel Boxer's fuze - | Whitworth -          | 4                                     | 17              | 1          | 0      | 27                               | 0          | 3      |
| Pillar fuze -          | M.L. Armstrong -     | 14                                    | 0               | 2          | 0      | 18                               | 7          | 0      |

In order to judge of the performances of these fuzes, these experiments must be considered together. From the results it appears that the pillar fuze when fired from the breech-loading Armstrong gun acted in a most satisfactory manner, but not so when fired from the muzzle-loading Armstrong gun, with which there were nine premature explosions in 32 rounds. Colonel Boxer's fuze acted in a very unsatisfactory manner, proving that it is not capable of resisting with any degree of certainty the effect of impact caused by ricochet on water.

The Committee having referred to the chemist of the War Department as to the liability of these fuzes to suffer deterioration from being kept in store for lengthened periods in different climates, have received a report from him to the effect that they are both perfectly calculated to ensure their permanent efficiency under all climatic conditions.

The Committee therefore have no hesitation in recommending Sir W. Armstrong's pillar fuze in preference to the corresponding sea service percussion fuze proposed by Colonel Boxer.

The Committee, in their preliminary report, have stated the reasons which induced them to select the 70-pounder guns for experiments as types of the three systems of artillery for garrison, siege, and naval purposes, upon which they were required to report; and the results obtained with these guns have, in their opinion, fully justified the Committee in the course they then adopted.

The Committee have further to observe that their instructions were simply to examine and report upon certain facts which required to be carefully ascertained before any satisfactory opinion can be pronounced upon the different descriptions of guns and of ammunition proposed by Sir W. Armstrong and Mr. Whitworth; they have accordingly endeavoured to bring out all these facts so far as could be done by the experiments they have made with the 12 and 70-pounder guns.

These facts are of the most complicated nature comprising numerous points of difference, many of which have an influence upon one another. If the instructions of the Committee had been to determine the best form of gun or system of artillery for the service, many of these points of difference must have been experimented upon, and investigated separately, with a view to ascertaining, if possible, the laws which regulate and should determine their conditions; such experiments, however, do not fall within



the instructions of the Committee, and as these various points cannot be determined by experiments with guns and systems of artillery, differing from each other in so many respects as those proposed by Sir W. Armstrong and Mr. Whitworth, the Committee do not think it advisable or necessary in the interests of the service to carry on any further experiments with the larger guns proposed and designed by either of those two gentlemen, but proceed to point out a few general deductions which they consider may fairly be drawn from the long course of experiments conducted by them.

The Committee consider it clearly established :—

1. That all three methods of rifling are practically efficient to produce the rotatory motion in the projectiles requisite to ensure accuracy of fire, which depends on other conditions independent of the precise mode of rifling.

2. That the projectiles when fired from guns rifled on either system do not act injuriously on the bores of steel barrels.

3. That projectiles coated with lead, or having soft metal projections (copper or zinc), are more liable to injury from rough usage than those the external surface of which is uniform of hard metal (iron or steel); they would, however, remark that the injuries from rough usage, to which the former projectiles are liable, would be rarely sufficient to render them even temporarily unserviceable.

4. That the latter projectiles are considerably less expensive than the lead-coated projectiles, and somewhat less so than projectiles with studs; as the cost of ammunition is a continually recurring expense, this is an item of great importance.

5. That the systems of lead-coating and soft metal studs, as applied by Sir W. Armstrong, empowers the use of the cylindrical or most capacious form of projectile, which in guns of large calibre is of great importance. They also provide the projectiles with a certain power of self-adjustment.

6. That steel when manufactured, tempered, and tested with great care, can be adopted with confidence for the barrels of guns of all calibres.

7. That guns fully satisfying all conditions of safety can be made with steel barrels, strengthened by super-imposed hoops of coil iron, and that such guns give premonitory signs of approaching rupture.

8. That guns fully satisfying all conditions of safety can be built up entirely of steel, but the employment of this material for the strengthening hoops requires that greater confidence should be established in the certainty and uniformity of its manufacture, when its adoption will become entirely a question of expense. The 70-pounder gun experimented with gave abundant premonitory signs of approaching rupture, whereas the 12-pounder burst violently, but not until it had sustained infinitely greater strains than it could possibly be subject to on service.

9. That at the present time wrought-iron coiled hoops are far less expensive than steel hoops.

10. That the greater strength of steel, and its uniformity in every direction give it more power when built up in guns to resist the force of impact of shot than coiled wrought iron.

11. That the wedge system of closing the breech adopted by Sir W. Armstrong with his 70-pounder guns, and recommended by him for all heavier breech-loaders, has proved itself very highly effective; although for various reasons, already stated in the body of their report, the Committee consider that muzzle-loading guns are better adapted for the general requirements of the service.

12. That the many grooved system of rifling, with its lead coated projectiles and complicated breech-loading arrangements, entailing the use of tin cups and lubricators, is far inferior for the general purposes of war, to both of the muzzle-loading systems, and has the disadvantage of being more expensive, both in original cost and in ammunition. The experiments with the 70-pounders have also developed a liability to injury from the fouling of the grooves by lead.

13. That the breech-loading system by the use of which guns can be loaded from the rear permits of the recoil being checked, of greater rapidity of fire, and of the condition of the bore being always readily inspected.

The Committee consider that these conditions point to the advantage to be derived by the use of the wedge breech-loading gun in certain positions, such as casemates for flanking ditches, &c.

14. That the breeches of muzzle-loading guns can be secured with perfect certainty by means of screws; the two systems proposed for closing the breech by Sir W. Armstrong and Mr. Whitworth cannot, however, be reported upon until the guns have been taken to pieces, which the Committee strongly recommend should be done after consultation with the respective makers of the guns.

15. That muzzle-loading rifled guns can be loaded and worked with perfect ease and abundant rapidity.

16. That their charges can also, when necessary, be drawn.

17. That the wear in the bores of guns is chiefly due to the effect of the products of the powder in rushing along the bore, and that this effect is greatest on the upper surface of the bore, and is more rapid on the metal whenever a sharp edge is presented to it; this effect was not perceptible in the breech-loading gun the bore of which was entirely closed by the projectile; it is therefore most desirable to prevent this rush of gas in muzzle-loading guns by a wad or other substance inserted over the powder.

18. That the lubricators at present used should be dispensed with. This can be done in muzzle-loading guns without in any way affecting their range, and with very little detriment in respect either of ease of loading or accuracy. The muzzle-loading Armstrong gun, within these limits, exhibited a considerable superiority to the Whitworth gun in ease of loading under these conditions.

19. That the large bore of Sir W. Armstrong's guns appears to have induced him, with a view of obtaining good results in range and accuracy, to employ hollow-headed instead of solid shot. The heads of these shot broke up on graze on the sands, and are liable to be broken if the projectiles are thrown down violently on any hard substance; also it is to be observed that this mode of giving length and form to a projectile is not applicable to steel shot.

20. That Mr. Whitworth's guns, with their comparatively small bores, have an advantage in penetration at long ranges. By long ranges the Committee do not understand extreme ranges, but ranges at which ships might engage each other, viz., from 1,000 to 1,500 yards.

21. That Sir William Armstrong's guns, with their comparatively large bores, from their power of consuming with advantage large charges of powder, and thus giving higher initial velocities to projectiles, have greater penetration and destructive effect at comparatively short ranges.

The Committee, however, desire to observe that, as explained in the body of their report, they have had no opportunity of testing the accuracy of the special projectiles proposed for use against iron plates either by Sir W. Armstrong or Mr. Whitworth, and that they were unable to pursue that very important branch of their inquiry which related to the penetration of iron plates when struck at an angle as will generally be the case on service.

22. That in cases in which excessive penetrations are not required, the power of Sir William Armstrong's guns, with their comparatively large bores, to fire long shells of very great capacity gives them a very great advantage as compared with Mr. Whitworth's smaller-bored guns.

23. That the ratio of twist in all the guns was such as to ensure very accurate results.

24. That it appears that both the accuracy and range of the Armstrong muzzle-loading gun are greatly increased when the 14-lb. charge is used; the Committee have to observe that this conclusion is derived from a limited number, viz., 27 rounds. As Mr. Whitworth's gun could not consume with advantage more powder than contained in the ordinary charge, the Committee had no opportunity of comparing the accuracy of that gun when fired with marked differences of initial velocity. They have, however, to remark, that when the top vent was used, the accuracy of Mr. Whitworth's gun was greatly increased, without any loss in range.

25. That although a vent in the axis of a muzzle-loading gun through the breech has certain advantages as regards the construction of the gun, the practical objections to its adoption greatly predominate.

26. That the nature of steel to be used in projectiles is a question of very great importance. In the very limited practice at iron plates placed at an angle which represents the circumstances under which naval warfare with armour-plated ships must in future mainly be carried on, the Committee particularly noticed the tendency of steel shot to break up on impact. This tendency, and the impossibility of obviating it, otherwise than by increased attention to the manufacture and proper tempering of steel give pressing and immediate importance to the question of that manufacture, and to the certainty of quality therein; and the Committee desire to point out that the employment of steel in the fabric of guns will be materially affected both in cost and otherwise, by the far larger inevitable employment of it in projectiles in future naval warfare.

27. That the system of loading steel shells from their front, as adopted by Sir W. Armstrong, instead of through their base, as adopted by Mr. Whitworth, is decidedly advantageous as productive of greater destructive effect when lodged in a ship's side. The construction of the former is, however, less favourable to their getting so lodged.



28. That Colonel Boxer's shrapnel shell is far superior in destructive effect to Sir W. Armstrong's segment shell, and that its employment does not require such an accurate judgment of distance or adjustment of fuze. It would, however, be desirable to fit it so as to allow of its being fired with both the percussion and time fuze.

29. That case shot may be fired from either of the guns, and that Mr. Whitworth's case shot is far superior in effect to that proposed for Sir W. Armstrong's gun.

30. That Colonel Boxer's wood time fuzes, of comparatively moderate cost are superior for the general requirements of the service, to the more expensive metal time fuzes proposed by Sir W. Armstrong.

31. That in the experiments conducted by the Committee there has been no decided superiority in either of the percussion fuzes as proposed by Sir W. Armstrong and Colonel Boxer ;

32. And that Sir W. Armstrong's pillar fuzes have maintained a superiority for naval purposes, not bursting by graze on water, but acting with effect against ships of ordinary scantling ; they require, however, care in packing and transport.

The Committee having frequently been pressed for their Report consider that they would fail in their duty, if they closed their proceedings without bringing to notice some of the principal causes which have operated to retard their progress.

1. The guns were not ready for practice before the 1st April 1864. The Committee were, therefore, not in a position to commence their experiments before that date.

2. During the course of the practice at Shoeburyness frequent delays arose from the very limited space available on the Government ground, which rendered it indispensable to conduct these experiments almost exclusively on the sands, and consequently dependent on the state of the tide ; so that not only was there the loss of time when the sands were covered, but during alternate weeks the favourable times of tide occurred during the night.

3. Considerable delay, labour, and inconvenience likewise resulted from the necessity of fixing the targets for practice during the ebb, and removing them before the next flood tide should overtake them.

4. The few experiments which were conducted on the marsh were subject to much loss of time owing to the frequent interruptions caused by passing vessels.

5. Great delay was further experienced from the want of sufficient magazine accommodation at Shoeburyness to contain the quantity of powder requisite for insuring a continuance of the experiments, this necessitated frequent requisitions for ammunition, the compliance with which in some instances occupied weeks.

The Committee have enumerated these, the chief causes, which have delayed their report, with the view of drawing attention to them and of suggesting that additional range and magazine accommodation would greatly tend to expedite the experiments upon which any future reports of a similar character would require to be based.

The Committee in conclusion have to express their high appreciation of the very valuable assistance rendered them by the officers and others of the establishments of the Schools of Gunnery at Shoeburyness, and on board Her Majesty's Ship "Excellent," and desire particularly to bring to notice the very great assistance they have derived from their secretary Major H. C. S. Dyer, R.A., and from Lieutenant Cruikshank, R.A., the officer especially appointed to aid them in their experiments.

(Signed) R. RUMLEY, Major-General, *President*.  
J. W. ORMSBY, Colonel, R.A.  
THOMAS WILSON, Captain, R.N.  
J. L. A. SIMMONS, Colonel, R.E.  
MORGAN SINGER, Captain, R.N.  
J. C. McDONALD.

The following signatures made subject to the reservations embodied in their separate letters.

A. J. TAYLOR, Major-General, Inspector-General of Artillery.  
C. F. YOUNG, Major, R.A.  
STUART RENDEL.

109, Victoria Street, London, S.W.,  
August 3rd, 1865.

H. DYER, Capt., R.A. and Bt.-Major,  
*Secretary*.

SIR, 109, Victoria Street, Westminster, August 3, 1865.

REFERRING to page lxxxvii., paragraph 12, of the final Report of the Armstrong and Whitworth Committee, I beg to place on record my dissent from the expression, "the experiments with the 70-prs. have also developed a liability to injury from the fouling of the grooves by lead."

1. I seconded the Amendment, which had for its object the substitution of the words "possibility of" in lieu of "liability to," considering that the extreme rarity of accidents of this kind made the former expression more just and appropriate.

Page lxxxvii., par. 13, latter part.

2. The amendment here proposed by me, and seconded by Major Young, R.A. I felt it necessary to suggest, considering that the words "such as casemates for flanking ditches" implies that this is a fair limit to assign to the capacity of the breech-loading 70-pr. Armstrong gun; whereas I am of opinion that as regards its destructive powers, except where great penetration is required, they are fully equal to all the requirements of service, while certain special qualities it possesses, such as its powers of rapid fire and independence of recoil on emergency, make it for siege and other special purposes a very valuable gun.

3. In recognizing the efficiency of Colonel Boxer's percussion fuze as used with the 70-prs., I still hold to the opinion I expressed of its having proved inferior to Sir W. Armstrong's in the 12-pr. trials.

I have, &c.

(Signed) A. J. TAYLOR,  
Major-General,  
Inspector-General of Artillery.

I FULLY concur in paragraphs 1 and 2 of the above.

(Signed) C. F. YOUNG,  
Captain R.A. and Major,  
Director of Artillery Studies.

To Major-General Rumley, President.

SIR, Woolwich, August 3, 1865.

I BEG to record my dissent to a part of the Report, page lxxxvi., which treats of the comparative cost of the Armstrong and Whitworth projectiles. It is there stated, that the mechanically fitting hard metal projectiles are somewhat less expensive than the studded projectiles. My reasons for dissenting from this are:—

1st. As the cylindrical form of the Armstrong projectile is certainly simpler than the hexagonal form of the Whitworth projectile there is less liability to failure in casting.

2nd. The proper action of the Whitworth projectile depends upon very accurate machine-work on its surfaces, whereas the bearing of the Armstrong projectile being taken by self-adjusting soft metal studs, the same minute accuracy of workmanship is not requisite: greater latitude for manufacturing error may thus be given to contractors for the supply of the latter projectiles, an item of considerable importance in respect of cost.

I have, &c.

(Signed) C. F. YOUNG,  
Capt. R.A. and Bt.-Major.

I BEG to concur in the opinion expressed in the above letter.—STUART RENDEL.

P.S. I beg to refer also to my concurrence with the two first paragraphs of General Taylor's letter of dissent. C. F. Y.

SIR, 109, Victoria Street, S.W., August 3, 1865.

WITH reference to the opinion expressed in the Committee's Report of this date, as to the relative merits of Sir W. Armstrong's and Colonel Boxer's time and percussion fuzes, I beg to refer to the expressions of dissent contained in my letter appended to the Committee's Preliminary Report.

As to the question of the comparative cost of the Armstrong studded and the Whitworth mechanically fitting projectiles, I beg leave to express my concurrence in the remarks of Major Young, R.A., appended to the report of this date, and to state my conviction that the Armstrong projectiles will prove to be considerably the cheaper projectile of the two.

I have, &c.

(Signed) STUART RENDEL.

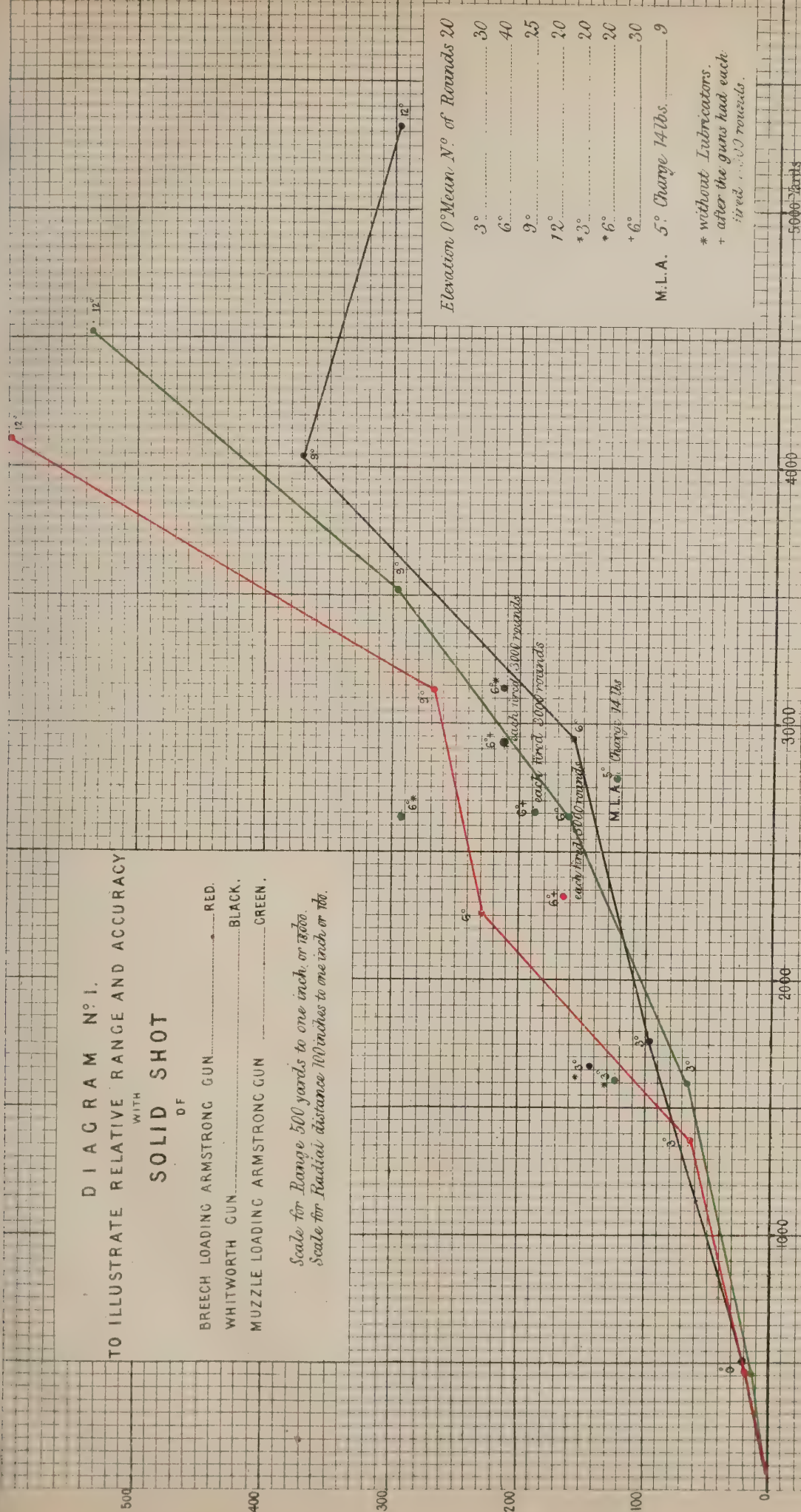
To the President,  
Armstrong and Whitworth Committee.



# DIAGRAM N° 1. TO ILLUSTRATE RELATIVE RANGE AND ACCURACY WITH SOLID SHOT OF

BREECH LOADING ARMSTRONG GUN ..... RED.  
WHITWORTH GUN ..... BLACK.  
MUZZLE LOADING ARMSTRONG GUN ..... GREEN.

Scale for Range 500 yards to one inch, or 1000.  
Scale for Radial distance 700 inches to one inch or 100.



Elevation 0° Mean. N° of Rounds 20

|       |    |
|-------|----|
| 3°    | 30 |
| 6°    | 40 |
| 9°    | 25 |
| 12°   | 20 |
| * 3°  | 20 |
| * 6°  | 20 |
| * 9°  | 20 |
| * 12° | 30 |

M.L.A. 5° Charge 14 lbs. 9

\* without Lubricators.  
+ after the guns had each  
fired 100 rounds.

5000 Yards

3000

2000

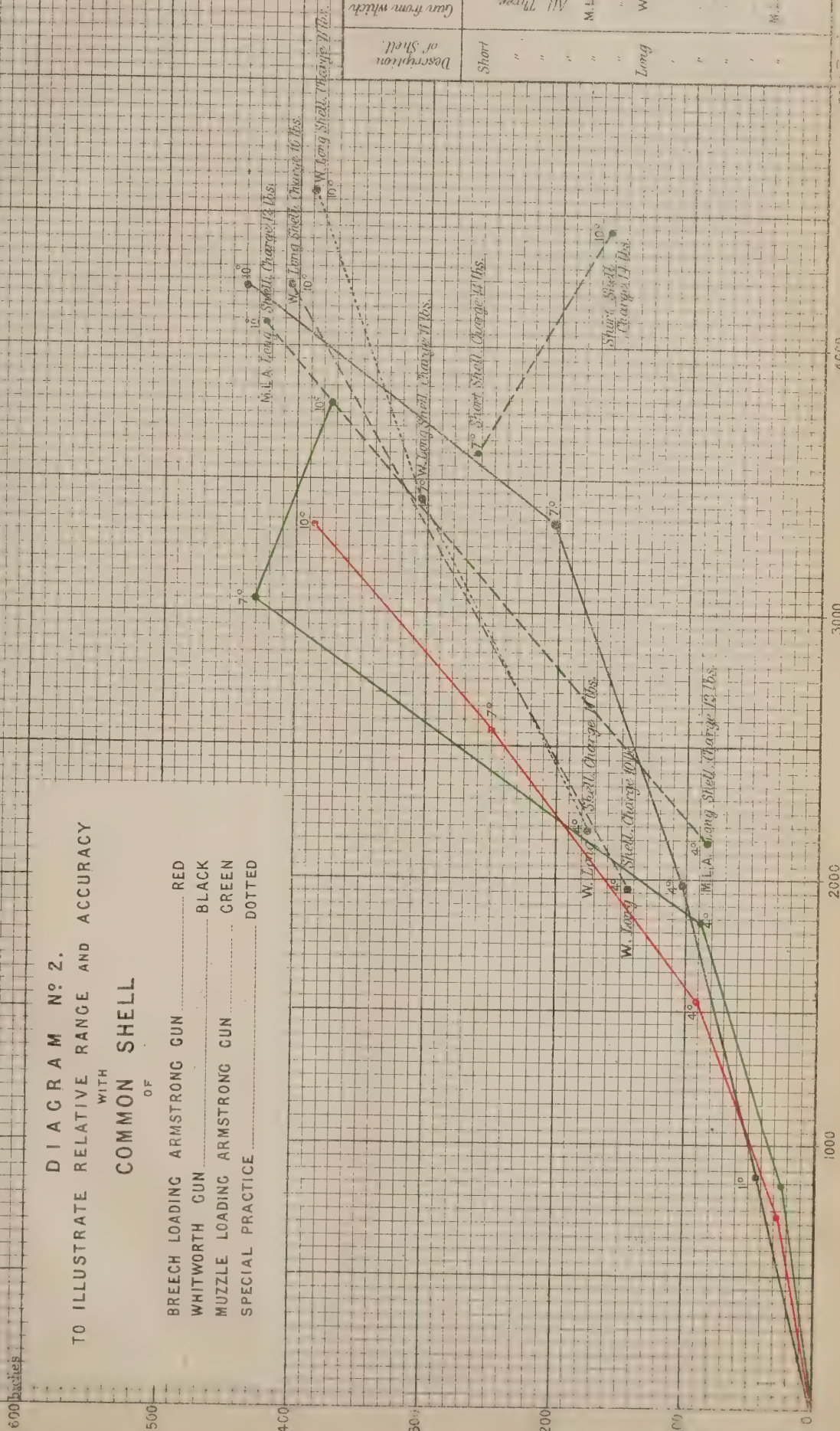
1000





# DIAGRAM N<sup>o</sup> 2. TO ILLUSTRATE RELATIVE RANGE AND ACCURACY WITH COMMON SHELL

BREECH LOADING ARMSTRONG GUN ..... RED  
WHITWORTH GUN ..... BLACK  
MUZZLE LOADING ARMSTRONG GUN ..... GREEN  
SPECIAL PRACTICE ..... DOTTED







600 inches

500

400

300

200

100

0

1000

2000

3000

4000

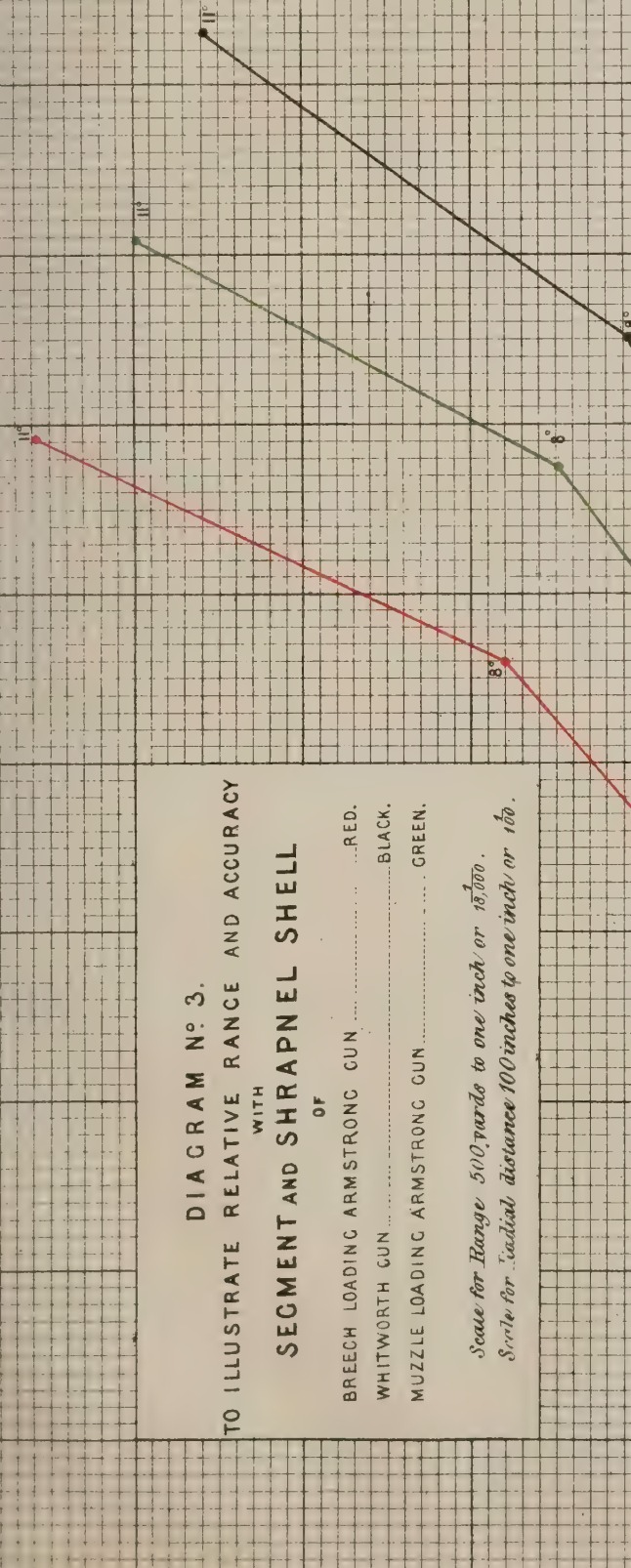
5000 Yards

DIAGRAM N<sup>o</sup> 3.  
TO ILLUSTRATE RELATIVE RANGE AND ACCURACY  
WITH  
OF  
SEGMENT AND SHRAPNEL SHELL  
BREECH LOADING ARMSTRONG GUN ..... RED.  
WHITWORTH GUN ..... BLACK.  
MUZZLE LOADING ARMSTRONG GUN ..... GREEN.

Scale for Range 500 yards to one inch or 15,000.  
Scale for radial distance 100 inches to one inch or 100.

Elevation 2° Mean N<sup>o</sup> of Rounds 30.

|     |       |    |
|-----|-------|----|
| 5°  | ..... | 16 |
| 8°  | ..... | 20 |
| 11° | ..... | 30 |







## PROCEEDINGS OF THE COMMITTEE.

109, Victoria Street, Westminster, February 27, 1865.

### MEMBERS PRESENT:

|                                         |                      |
|-----------------------------------------|----------------------|
| MAJOR-GENERAL RUMLEY, <i>President.</i> |                      |
| MAJOR-GENERAL TAYLOR, R.A.              | CAPTAIN SINGER, R.N. |
| COLONEL ORMSBY, R.A.                    | MR. McDONALD.        |
| CAPTAIN WILSON, R.N.                    | MR. STUART RENDEL.   |
| COLONEL SIMMONS, C.B., R.E.             |                      |
| MAJOR DYER, R.A., <i>Secretary.</i>     |                      |

The Draft Report was read.

Page 1, line 17, Draft; now page iii., line 19, Report.

Proposed by *Captain Wilson*, That the following words be added:—"and of which the following is a summary," after the word "Appendix."

Carried *Nem. con.*

Page 1, line 18, Draft; now page iii., line 20, Report.

Proposed by *Mr. McDonald*, seconded by *Colonel Ormsby*, That the following words be omitted:—"which extend to a very complete system of artillery for all services."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Mr. McDonald.    | General Taylor. |
| Colonel Ormsby.  | Captain Wilson. |
| Colonel Simmons. | Captain Singer. |
|                  | Mr. Rendel.     |

Agreed, That the following words be substituted:—"which are very comprehensive."

Page 1, line 45, Draft; now page iii., line 36, Report.

Proposed by *General Taylor*, That the following words be omitted:—"passed in through an opening in the side of the gun."

Carried *Nem. con.*

Agreed, That the following words be substituted:—"worked in a groove through an opening in the side of the gun."

Page 3, lines 20 to 33, Draft; now page iv., lines 44 and 45, Report.

Proposed by *Colonel Simmons*, That these lines be omitted, and that the paragraph run and be embodied as follows:—"Guns so constructed may be described as coil guns with steel tubes or barrels, or as steel barrels with superimposed coils of wrought iron."

Carried *Nem. con.*

Page 3, line 45, Draft; now page iv., line 51, Report.

Proposed by *Mr. Rendel*, That the following words be inserted:—"or with pillar fuzes."

Carried *Nem. con.*

Page 3, line 53, Draft; now page iv., line 56, Report.

Proposed by *Mr. Rendel*, That the following paragraph be inserted:—"The pillar fuze is a variety of percussion fuze intended for action against ships."

Carried *Nem. con.*

Page 4, lines 47 and 48, Draft; now page v., lines 29 and 30, Report.

Proposed by *Mr. Rendel*, That these lines read as follows:—"Mr. Whitworth designates the calibre of his gun by the diameter of the circumscribing circle."

Carried *Nem. con.*

Page 5, lines 59 and 60, Draft; now page vi., line 28, Report.

Proposed by *Mr. Rendel*, seconded by *General Taylor*, That the following words be omitted:—"but on the other hand, certain defects in construction were frequently brought to the notice of the Committee."

## The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Ormsby.  |
| General Taylor. | Colonel Simmons. |
| Captain Singer. | Captain Wilson.  |
|                 | Mr. McDonald.    |

Page 5, line 63, Draft; now page vi., line 52, Report.

Proposed by *Captain Singer*, That the word "frequent" be omitted, and the number of rounds substituted.

Amendment.—Proposed by *Colonel Simmons*, seconded by *General Taylor*, That the words "frequent" and "to be occasionally" be omitted, and the paragraph run as follows:—"require re-facing and renewal after a certain number of rounds, dependent on the care and attention with which the action of the powder is observed."

Carried *Nem. con.*

109, *Victoria Street, Westminster, February 28, 1865.*

## MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President.*

|                             |                                     |
|-----------------------------|-------------------------------------|
| MAJOR-GENERAL TAYLOR, R.A.  | CAPTAIN SINGER, R.N.                |
| COLONEL ORMSBY, R.A.        | MAJOR YOUNG, R.A.                   |
| CAPTAIN WILSON, R.N.        | MR. McDONALD.                       |
| COLONEL SIMMONS, C.B., R.E. | MR. STUART RENDEL.                  |
|                             | MAJOR DYER, R.A., <i>Secretary.</i> |

Page 6, lines 13 and 14, Draft; now page vi., lines 61 and 62, Report.

Proposed by *Captain Singer*, seconded by *Mr. Rendel*, That the words "and since then" be omitted, and "having" substituted for "has."

## The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Captain Singer.  | Colonel Ormsby. |
| Mr. Rendel.      | Mr. McDonald.   |
| Major Young.     | Captain Wilson. |
| General Taylor.  |                 |
| Colonel Simmons. |                 |

Page 6, line 34, Draft; now page vii., line 7, Report.

Proposed by *Mr. Rendel*, seconded by *General Taylor*, That from the word "China" to the end of the sentence be omitted, and that the paragraph precede the one commencing "Captain Seymour."

Carried *Nem. con.*

Page 6, line 21, Draft; now page vii., line 4, Report.

Proposed by *Captain Singer*, seconded by *General Taylor*, That the following be added:—"through the carelessness of the man who was trusted to screw it up."

Carried *Nem. con.*

Page 6, line 21, Draft; now page vii., line 5, Report.

Proposed by *Mr. Rendel*, seconded by *General Taylor*, That from the word "China" to the end of the sentence be omitted.

## The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Simmons. |
| General Taylor. | Colonel Ormsby.  |
| Captain Singer. | Major Young.     |
| Captain Wilson. | Mr. McDonald.    |
|                 | General Rumley.  |

Page 6, paragraph 6, Draft; now page vii., paragraph 5, Report.

Proposed by *Mr. Rendel*, not seconded, That this paragraph be omitted:—"Two similar accidents were reported to have occurred with the guns of the Royal Artillery in New Zealand."

Page 6, line 21, Draft; now page vii., line 4, Report.

Proposed by *Colonel Simmons*, That the date of the war in China be inserted.

Carried *Nem. con.*

Page 6, lines 36 to 45, Draft; now page vii., lines 14 to 19, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the paragraph relating to Kogosima be left out until the Report is before the Committee.

Carried *Nem. con.*



Page 6, lines 53 to 57, Draft; now page vii., lines 23 to 26, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That the following words be omitted :—  
“on active service, may be considered as indicative only of what might be expected in more serious affairs, such as a general action or decisive battle, in which a numerous artillery would be employed; combined with other evidence.”

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Simmons. |
| Captain Singer. | Colonel Ormsby.  |
| General Taylor. | Major Young.     |
|                 | Mr. McDonald.    |
|                 | Captain Wilson.  |

Page 6, paragraph 9, Draft; now page vii., paragraph 7, Report.

Proposed by *General Taylor*, seconded by *Mr. Rendel*, That a paragraph, as follows, be inserted after the above :—“That the Committee considers it right to observe that the majority of the evidence bearing on this point has reference to the vent pieces of the old pattern.”

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| General Taylor. | Colonel Simmons. |
| Mr. Rendel.     | Colonel Ormsby.  |
| Captain Singer. | Major Young.     |
| Captain Wilson. | Mr. McDonald.    |
|                 | General Rumley.  |

Page 7, line 3, Draft; now page vii., line 33, Report.

Proposed by *Mr. Rendel*, seconded by *General Taylor*, That the following words be omitted :—  
“and only tall strong men are able to manage it.”

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Simmons. |
| General Taylor. | Major Young.     |
| Colonel Ormsby. | Mr. McDonald.    |
| Captain Wilson. |                  |
| Captain Singer. |                  |

Page 7, line 5, Draft; now page vii., line 43, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That the words “of the old pattern” be inserted.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Simmons. |
| Captain Singer. | Major Young.     |
| General Taylor. | Mr. McDonald.    |
| Colonel Ormsby. |                  |
| Captain Wilson. |                  |

Page 7, lines 18 to 25, Draft; now page vii., lines 50 to 55, Report.

Proposed by *General Taylor*, That his evidence on this point be quoted *in extenso*.

Carried *Nem. con.*

Page 10, after paragraph 1, Draft; now page ix., paragraph 6, Report.

Proposed by *Mr. Rendel*, That the following paragraph be inserted :—“Major Milward, R.A., who commanded a field battery in China, stated, however, that his shells, although they had a great deal of knocking about from the nature of the service on which they were employed, were not in any way damaged.”

Carried *Nem. con.*

The draft Report to page 12 was discussed.

109, Victoria Street, Westminster, March 1, 1865..

MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President*.

|                             |                                      |
|-----------------------------|--------------------------------------|
| MAJOR-GENERAL TAYLOR, R.A.  | CAPTAIN SINGER, R.N.                 |
| COLONEL ORMSBY, R.A.        | MAJOR YOUNG, R.A.                    |
| CAPTAIN WILSON, R.N.        | MR. McDONALD.                        |
| COLONEL SIMMONS, C.B., R.E. | MR. STUART RENDEL.                   |
|                             | MAJOR DYER, R.A., <i>Secretary</i> . |

Proposed by *Colonel Simmons*, seconded by *Major Young*, That a paragraph as to the constitution of the Committee be discussed to-morrow.

Carried *Nem. con.*

Page 12, after paragraph 1, Draft ; now page x., after paragraph 8, Report.

Proposed by *Mr. Rendel*, not seconded, That the following paragraph be inserted:—"This raises a question whether the hermetically closing of fuzes, for the purpose of excluding damp, is an advantage or otherwise."

Amendment.—Proposed by *Captain Singer*, seconded by *Mr. Rendel*, "This applies equally to all percussion fuzes, and is not common to these fuzes."

The Committee divided.

*For.*  
Captain Singer.  
Mr. Rendel.

*Against.*  
Mr. McDonald.  
Colonel Ormsby.  
Colonel Simmons.  
Major Young.  
Captain Wilson.  
General Taylor.

Page 12, paragraph 3, Draft ; now page x., paragraph 10, Report.

Proposed by *Mr. Rendel*, seconded by *Colonel Simmons*, That this paragraph run as follows:—"With regard to the pillar fuzes, the Committee have been informed that they answer well in firing, and they have had no evidence of any accident having occurred with them on service or at practice. A pillar fuze belonging to the first batch, manufactured in the Royal Laboratory, exploded while in course of removal from the laboratory to the store, and in consequence, none of that batch, 15,000 in number, were issued. These fuzes are also considered as too delicate and liable to accidents by Colonel Boxer, R.A. ; and Captain Bent, R.A., Assistant Superintendent of the Laboratory at Devonport, stated, in February 1863, that they had been in the service some year or a year and a half, but in the course of that time they became so fixed in the shell that it is very dangerous indeed to remove them ; he added, however, 'that none had exploded.'"

Carried *Nem. con.*

Page 12, line 38, Draft ; page x., line 62, Report.

Proposed by *Major Young*, seconded by *Captain Singer*, That the word "wooden" be omitted, and "of the service" inserted.

Carried *Nem. con.*

Page 5, after paragraph 8, Draft ; now page vi., paragraph 5, Report.

Proposed by *Mr. Rendel*, That the following paragraph be inserted:—"With reference to the range attained by these guns, Major Milward, R.A., who commanded a battery in China in 1860, stated his opinion that 'we have no occasion for a longer range.' Major Milman, R.A., Captain Instructor at Shoeburyness, considered 'that as long a range can be got with this gun as would ever be required on service.' Lieut. Liddell, R.N., for four years gunnery Lieutenant of the 'Excellent,' stated that 'the range of every description of Armstrong gun in the service is quite sufficient for actual service.' Mr. Bechervaise, an instructor of the 'Excellent,' said that in his opinion 'the range is everything that can be required for ordinary service.'"

Carried *Nem. con.*

Page 5, after paragraph 9, Draft ; now page vi., after paragraph 6, Report.

Proposed by *Mr. Rendel*, seconded by *General Taylor*, That the following paragraph be inserted:—"The evidence taken in reference to the 20-pr. and 40-pr. Armstrong guns has been generally favourable."

The References:—

Milman, 787.  
Alderson, 690.  
Gardner, 2634.

Hewlett, 2147.  
Bechervaise, 1207.  
Hay, 1843.

The Committee divided.

*For.*  
Mr. Rendel.  
General Taylor.  
Captain Wilson.  
Captain Singer.

*Against.*  
Mr. McDonald.  
Colonel Ormsby.  
Colonel Simmons.  
Major Young.  
General Rumley.

Amendment.—Proposed by *Captain Singer*, seconded by *Major Young*, "That it is desirable to consider a paragraph in reference to the 40-pr. Armstrong gun, on Monday next, 6th March.

Carried *Nem. con.*

Page 13, after paragraph 1, Draft ; now page xi., paragraph 4, Report.

Proposed by *Colonel Simmons*, seconded by *Major Young*, That the following paragraph be inserted:—"A general opinion also appears to prevail that the employment of the segment shell does not do away with the necessity of having guns in the field adapted for firing common shells capable of containing adequate bursting charges."

Carried *Nem. con.*



Page 13, after paragraph 2, Draft ; now page xi, paragraph 6, Report.

Proposed by *Mr. Rendel*, seconded by *Colonel Simmons*, That the following paragraph be inserted:—"From the evidence taken by the Committee in January 1863, with respect to the penetration of iron plates, it appeared that Sir W. Armstrong had penetrated with a shell into the backing of a 'Warrior' target, and blown a hole through the skin with a 110-pr. gun at 200 yards' range."

Carried *Nem. con.*

109, Victoria Street, Westminster, March 2, 1865.

MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President.*

MAJOR-GENERAL TAYLOR, R.A.

COLONEL ORMSBY, R.A.

CAPTAIN WILSON, R.N.

COLONEL SIMMONS, C.B., R.E.

CAPTAIN SINGER, R.N.

MAJOR YOUNG, R.A.

MR. McDONALD.

MR. STUART RENDEL.

MAJOR DYER, R.A., *Secretary.*

Page 1, paragraph 2, Draft ; now page iii, paragraph 2, Report.

Proposed by *Colonel Simmons*, seconded by *Major Young*, That the paragraph relative to the constitution of the Committee be paragraph 2.

Carried *Nem. con.*

Page 5, after paragraph 8, Draft ; now page vi., paragraph 6, Report.

Proposed by *Mr. Rendel*, seconded by *Major Young*, a paragraph relating to safety of guns.

Amendment.—Proposed by *Mr. McDonald*. Not seconded.

Amendment.—Proposed by *Colonel Ormsby*, seconded by *Colonel Simmons*, That the words "on Sir W. Armstrong's plan" be substituted for the words "system of Sir W. Armstrong."

The Committee divided.

*For.*

Colonel Ormsby.

Colonel Simmons.

*Against.*

Major Young.

Captain Singer.

Mr. Rendel.

Captain Wilson.

General Taylor.

The division on the original question is as follows:—

*For.*

Mr. Rendel.

Major Young.

Colonel Ormsby.

Colonel Simmons.

Captain Singer.

Captain Wilson.

General Taylor.

*Against.*

Mr. McDonald.

*Colonel Simmons* to prepare a paragraph to follow the one on page 5, Draft (page vi., Report) for consideration.

Carried *Nem. con.*

Page 17, Draft ; now page xiv., lines 7, 8, and 9, Report.

Proposed by *Captain Singer*, seconded by *General Taylor*, That the following paragraph be inserted:—"Great delays took place ; the causes of these delays and the steps the Committee took with the view of obviating the inconvenience that might ensue to the public service will be found in the Appendix."

Carried *Nem. con.*

Page 18, table, Draft ; now page xv., table, Report.

Proposed by *Mr. Rendel*, That the diameters of the circumscribing and inscribing circle in Whitworth guns be inserted in this table.

Carried *Nem. con.*

Page 18, table, Draft ; now page xv., table, Report.

Proposed by *Mr. Rendel*, That the tables in that and following tables be followed by a table showing relative weights of gun and lengths of bore.

Carried *Nem. con.*

Page 19, Draft ; now page xvii., paragraph 1, Report.

Proposed by *Colonel Simmons*, seconded by *General Taylor*, That the following paragraph be substituted for first paragraph after 70-pr. table:—"The Committee have, in a previous part of the Report, detailed the description given by Sir W. Armstrong, in January 1863, of the manner in which his guns are constructed, exhibiting the condition in that respect of his system at that period, since which it appears that such progress has been made in the manufacture of steel that all the guns submitted to the Committee for experiment, except one of the 70-pr. breech-loaders, were constructed of steel inner tubes with wrought-iron coils superimposed, which, in the case of field guns, extended only from the breech to a short distance in front of the trunnions."

Amendment.—Proposed by *Mr. Rendel*, seconded by *General Taylor*, That the words "by Sir W. Armstrong," and "and proved before the 18th July 1863," be inserted after the word "experiment."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Mr. McDonald.    |
| General Taylor. | Colonel Ormsby.  |
|                 | Colonel Simmons. |
|                 | Major Young.     |
|                 | Captain Singer.  |
|                 | Captain Wilson.  |

The former proposal being put, was carried *Nem. con.*

Page 5, after paragraph 8, Draft ; now page vi., paragraph 6, Report.

Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the paragraph as to the safety of the guns stand.

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Simmons. | Major Young.    |
| Colonel Ormsby.  | Mr. Rendel.     |
| Captain Singer.  |                 |
| Captain Wilson.  |                 |

Proposed, That outline drawings, showing in a general way the metals of which the guns are constructed, be made.

Carried *Nem. con.*

Page 19, Draft ; now page xvii., paragraph 2, Report.

Proposed by *Colonel Simmons*, That the paragraph as follows be inserted:—"The 12-pr. guns as first delivered to the Committee by Mr. Whitworth were constructed of solid steel, having trunnion rings screwed on to them."

Carried *Nem. con.*

109, Victoria Street, Westminster, March 15, 1865.

#### MEMBERS PRESENT:

MAJOR-GENERAL RUMLEY, *President.*

|                             |                                     |
|-----------------------------|-------------------------------------|
| MAJOR-GENERAL TAYLOR, R.A.  | CAPTAIN SINGER, R.N.                |
| COLONEL ORMSBY, R.A.        | MAJOR YOUNG, R.A.                   |
| CAPTAIN WILSON, R.N.        | MR. McDONALD.                       |
| COLONEL SIMMONS, C.B., R.E. | MR. STUART RENDEL.                  |
|                             | MAJOR DYER, R.A., <i>Secretary.</i> |

Page 24, Draft ; now page xviii., Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That a note be appended stating that the per-centage is taken on the inferior range.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Ormsby.  |
| Captain Singer. | Colonel Simmons. |
| General Taylor. | Captain Wilson.  |
|                 | Mr. McDonald.    |
|                 | Major Young.     |

Page 23, Draft ; now page xxii., Report.

A foot note to be inserted stating where the junk and stearine wad was used for M.-L. Armstrong, and where the lubrication for B.-L. Armstrong and Whitworth was used.

Carried *Nem. con.*



Page 26, lines 13, 14, 15, after table, Draft; now page xx., line 12, after table, Report.

Proposed by *Mr. McDonald*, seconded by *General Taylor*, That the following words be omitted :—  
“ which gives about the maximum range at which this description of projectile can be used with effect.”

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Mr. McDonald.    | Captain Singer. |
| General Taylor.  | Major Young.    |
| Colonel Ormsby.  |                 |
| Colonel Simmons. |                 |

Page 31, line 3, Draft; now xxiii., line 11, after table, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That the following words be inserted :—  
“ the latter projectile not being at present used with rifled field pieces.”

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Ormsby.  |
| Captain Singer. | Colonel Simmons. |
| Major Young.    | Captain Wilson.  |
| General Taylor. | Mr. McDonald.    |
| General Rumley. |                  |

Proposed by *Mr. Rendel*, seconded by *General Taylor*, That tables be prepared showing the relative accuracy of the field guns with common shell in a form similar to the other tables.

A remark to be added in reference to the small number of rounds fired.

Carried *Nem. con.*

Page 33, paragraph 4, Draft; now page xxvi., paragraph 6, Report.

Proposed by *General Taylor*, seconded by *Major Young*, That the paragraph relating to the danger of field fire in breech-loading guns be omitted.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| General Taylor. | Colonel Ormsby.  |
| Major Young.    | Colonel Simmons. |
| Mr. Rendel.     | Captain Singer.  |
|                 | Captain Wilson.  |
|                 | Mr. McDonald.    |

Page 33, paragraph 5, Draft; now page xxvi., after paragraph 6, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following words be omitted :—  
“ the risk incurred by loading a breech-loader without sponging, or by—”

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Captain Singer. | Colonel Ormsby.  |
| Major Young.    | Colonel Simmons. |
| Mr. Rendel.     | Mr. McDonald.    |
| Captain Wilson. |                  |

Page 33, paragraph 5, Draft; now page xxvi., after paragraph 6, Report.

Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the following paragraph be omitted :—“ On an emergency, where an object of great importance is to be gained, such as the delivery of a few rounds very rapidly on an advancing enemy at short range, the risk incurred by loading a breech-loader without sponging, or by this change in the drill of the breech-loader, would be quite allowable; but the Committee consider it is not admissible in the ordinary practice of a battery, where the guns should be carefully laid and steadily fired.”

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Simmons. | Captain Singer. |
| Colonel Ormsby.  | Mr. Rendel.     |
| Major Young.     |                 |
| Captain Wilson.  |                 |
| Mr. McDonald.    |                 |

Major-General Taylor absent on duty at this division.

109, Victoria Street, Westminster, March 16, 1865.

## MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President*.

MAJOR-GENERAL TAYLOR, R.A.

COLONEL ORMSBY, R.A.

CAPTAIN WILSON, R.N.

COLONEL SIMMONS, C.B., R.E.

CAPTAIN SINGER, R.N.

MAJOR YOUNG, R.A.

MR. STUART RENDEL.

MR. McDONALD.

MAJOR DYER, R.A., *Secretary*.

Page 32, last line, Draft; now page xxvi, line 9, Report.

Proposed by *Mr. Rendel*, seconded by *Major Young*, That the words "according to custom" be inserted.

The Committee divided.

*For.*  
Mr. Rendel.  
Major Young.  
Captain Singer.  
General Taylor.

*Against.*  
Colonel Simmons.  
Captain Wilson.  
Colonel Ormsby.

Page 32, last line, Draft; now page xxvi, line 9, Report.

Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the following words be inserted after the word "custom":—"when they become heated."

The Committee divided.

*For.*  
Colonel Simmons.  
Colonel Ormsby.  
Captain Wilson.  
General Taylor.

*Against.*  
Major Young.  
Captain Singer.  
Mr. Rendel.

Page 34, paragraph 4, Draft; now page xxvi, last paragraph, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That the paragraph commencing, "The Committee had found" stand.

The Committee divided.

*For.*  
Mr. Rendel.  
Captain Singer.  
Colonel Ormsby.  
Colonel Simmons.  
Major Young.  
General Taylor.

*Against.*  
Captain Wilson.  
Mr. McDonald.

Page 34, paragraph 3, Draft; now page xxvi, last paragraph, Report.

Proposed by *General Taylor*, seconded by *Major Young*, That the words "continuously without lubrication" be inserted.

The Committee divided.

*For.*  
General Taylor.  
Major Young.  
Captain Singer.  
Mr. Rendel.  
Captain Wilson.

*Against.*  
Colonel Ormsby.  
Colonel Simmons.

Page 34, after paragraph 3, Draft; now page xxvii, line 4, Report.

Proposed by *Captain Wilson*, That the following paragraph be inserted:—"The breech-loading apparatus also jammed, owing probably to the air space left by the abstraction of the lubricator."

Carried *Nem. con.*

Page 34, line 37, Draft; now page xxvii, line 12, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That the following words be omitted:—"and the breech-loading apparatus in working order."

The Committee divided.

*For.*  
Mr. Rendel.  
Captain Singer.  
Colonel Ormsby.  
Colonel Simmons.  
Major Young.  
General Taylor.

*Against.*  
Captain Wilson.



Page 35, lines 25 to 32, Draft ; now page xxvii., lines 41 to 45, Report.

Proposed by *Captain Wilson*, seconded by *Mr. Rendel*, That the concluding portion of the paragraph running as follows, be omitted :—"The Committee, however, did not feel themselves justified in incurring the risk of injury to the men of the gun detachment, which would have resulted from a trial for comparison of the expedient which might be resorted to on service, of firing a few rounds upon an advancing enemy at short range from the muzzle-loading guns without sponging."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Captain Wilson. | Colonel Ormsby.  |
| Mr. Rendel.     | Colonel Simmons. |
| General Taylor. | Captain Singer.  |
|                 | Major Young.     |
|                 | Mr. McDonald.    |

Page 35, lines 35 to 39, Draft ; now page xxvii., lines 47 to 49, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following words be omitted :—"both of which the Committee consider might probably have been reduced nearly to an equality with the breech-loader if the process of sponging had been omitted, and a careful selection made of their gun detachments."

Amendment.—Proposed by *General Taylor*, seconded by *Captain Wilson*, That the words "for the purposes of experiment" be inserted after the word "if."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| General Taylor. | Colonel Ormsby.  |
| Captain Wilson. | Colonel Simmons. |
| Captain Singer. | Major Young.     |
| Mr. Rendel.     | Mr. McDonald.    |
| General Rumley. |                  |

Page 36, line 25, Draft ; now page xxviii., line 26, Report.

Proposed by *Captain Singer*, seconded by *Mr. Rendel*, That the sentence run as follows :—"The sides of the slot were considerably scored by the escape of gas round the vent-piece."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Captain Singer. | Colonel Ormsby.  |
| Mr. Rendel.     | Colonel Simmons. |
|                 | Major Young.     |
|                 | Captain Wilson.  |
|                 | Mr. McDonald.    |

Page 37, paragraph 2, Draft ; now page xxviii., last paragraph, Report.

Proposed by *Mr. Rendel*, seconded by *Major Young*, That the paragraph relative to loss of range be omitted.

Amendment.—Proposed by *Captain Singer*, seconded by *Mr. Rendel*, That the paragraph run as follows :—"These losses in range are in some measure due to the wear of the three guns."

Carried *Nem. con.*

Page 36, after paragraph 2, Draft ; now page xxviii., paragraph 4, Report.

Proposed by *Mr. McDonald*, seconded by *General Taylor*, That the following paragraph be inserted :—"The two muzzle-loading guns have in the same total number of rounds consumed 700 lbs. of powder beyond the breech-loader."

The Committee divided.

| <i>For.</i>      |
|------------------|
| Mr. McDonald.    |
| General Taylor.  |
| Colonel Ormsby.  |
| Colonel Simmons. |
| Major Young.     |

Amendment.—Proposed by *Captain Singer*, seconded by *Mr. Rendel*, That all the amounts of powder be stated.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Captain Singer. | Colonel Ormsby.  |
| Mr. Rendel.     | Colonel Simmons. |
| Major Young.    |                  |
| Captain Wilson. |                  |
| General Taylor. |                  |

109, Victoria Street, Westminster, April 4, 1865.

MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President*.

MAJOR GENERAL TAYLOR.  
COLONEL ORMSBY, R.A.  
CAPTAIN WILSON, R.N.  
COLONEL SIMMONS, C.B., R.E.

CAPTAIN SINGER, R.N.  
MAJOR YOUNG, R.A.  
MR. STUART RENDEL.  
MR. McDONALD.  
MAJOR DYER, R.A., *Secretary*.

Page 7, after paragraph 6, Draft ; now page vii., paragraph 10, Report.

Proposed by *General Taylor*, seconded by *Captain Wilson*, That the paragraph relative to the 40-pr. proposed be now considered.

Amendment.—Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*.

The Committee divided.

*For.*  
Colonel Simmons.  
Colonel Ormsby.

*Against.*  
Captain Wilson.  
Major Young.  
Captain Singer.  
General Taylor.  
Mr. Rendel.

On *General Taylor's* motion, That the paragraph be inserted—

The Committee divided.

*For.*  
General Taylor.  
Captain Wilson.  
Major Young.  
Captain Singer.  
Mr. Rendel.

*Against.*  
Colonel Ormsby.  
Colonel Simmons.  
Mr. McDonald.

Page 14, after paragraph 1, Draft ; now page xi., paragraph 7, Report.

Proposed by *Mr. Rendel*, A paragraph relative to "Penetration of iron plates by Armstrong guns."

Amendment.—Proposed by *Captain Wilson*, seconded by *Captain Singer*, That the paragraph run as follows :—"Sir W. Armstrong has also constructed guns of great calibre and power, which are reported by the Iron Plate Committee to be capable of penetrating at long ranges any iron target that has as yet been fired at."

The Committee divided.

*For.*  
Captain Wilson.  
Captain Singer.  
Colonel Simmons.  
General Taylor.

*Against.*  
Colonel Ormsby.  
Mr. Rendel.  
Major Young.

Page 15, after paragraph 5, Draft ; now page xii., paragraph 7, Report.

Proposed by *Colonel Simmons*, seconded by *Mr. McDonald*, That a paragraph relative to Mr. Whitworth's guns and projectiles against iron plates be inserted, to run as follows :—"So far as the Committee have been informed, no experiments have been made with any of Mr. Whitworth's guns and projectiles to test their power of penetrating iron targets subsequent to those reported as having taken place early in 1863."

Amendment.—Proposed by *Mr. Rendel*, That the words "by Mr. Whitworth to test the power of his guns or projectiles in penetrating iron targets" be substituted for the words "no experiments have been made with any of Mr. Whitworth's guns and projectiles."

On *Colonel Simmons's* motion, the Committee divided.

*For.*  
Colonel Simmons.  
Mr. McDonald.  
Colonel Ormsby.  
Major Young.  
Captain Wilson.  
General Taylor.

*Against.*  
Mr. Rendel.  
Captain Singer.



109, Victoria Street, Westminster, April 5, 1865.

MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President*.

MAJOR-GENERAL TAYLOR, R.A.  
COLONEL ORMSBY, R.A.  
CAPTAIN WILSON, R.N.  
COLONEL SIMMONS, R.E., C.B.

CAPTAIN SINGER, R.N.  
MAJOR YOUNG, R.A.  
MR. STUART RENDEL.  
MR. McDONALD.

MAJOR DYER, R.A., *Secretary*.

Page 39, paragraph 3, Draft ; now page xxxi., paragraph 4, Report.

Proposed by *Major Young*, seconded by *Captain Singer*, That this paragraph be omitted.

The Committee divided.

*For.*

Major Young.  
Captain Singer.  
Mr. Rendel.  
General Taylor.

*Against.*

Colonel Ormsby.  
Colonel Simmons.  
Captain Wilson.  
Mr. McDonald.  
General Rumley.

Page 39, paragraph 7, Draft ; now page xxxi., paragraph 8, Report.

Proposed by *Captain Wilson*, That the following sentence be added to this paragraph:—"These vent-pieces are supplied in triplicate for exchange."

Carried *Nem. con.*

Page 39, line 35, Draft ; now page xxxi., line 27, Report.

Proposed by *Major Young*, seconded by *Colonel Ormsby*, That the words "three parts" be omitted.

The Committee divided.

*For.*

Major Young.  
Colonel Ormsby.  
Mr. Rendel.  
Captain Wilson.  
General Taylor.

*Against.*

Colonel Simmons.  
Captain Singer.

Page 39, after last paragraph, Draft ; now page xxxi., after paragraph 11, Report.

Proposed by *General Taylor*, seconded by *Mr. Rendel*, A paragraph as follows:—"It is to be observed that the use of the vent-piece precludes the necessity of bouching implements for venting the guns."

The Committee divided.

*For.*

General Taylor.  
Mr. Rendel.

*Against.*

Colonel Ormsby.  
Colonel Simmons.  
Major Young.  
Captain Singer.  
Captain Wilson.

Page 40, paragraph 1, Draft ; now page xxxi., paragraph 12, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That this paragraph be omitted.

The Committee divided.

*For.*

Captain Singer.  
Major Young.  
Mr. Rendel.  
General Taylor.

*Against.*

Colonel Ormsby.  
Colonel Simmons.

Amendment.—Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the following words be added after the word "might":—"under certain circumstances."

The Committee divided.

*For.*

Colonel Simmons.  
Colonel Ormsby.  
Captain Wilson.

*Against.*

Major Young.  
Captain Singer.  
Mr. Rendel.  
General Taylor.

Amendment.—Proposed by *General Taylor*, seconded by *Colonel Ormsby*, That the paragraph run as follows:—"The loss of the tools, or the absence of men skilled in the use of them, might seriously impair the efficiency of a battery in a campaign."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| General Taylor.  | Major Young.    |
| Colonel Ormsby.  | Captain Singer. |
| Colonel Simmons. | Mr. Rendel.     |
| Captain Wilson.  |                 |

Page 41, paragraph 2, Draft ; now page xxxii., paragraph 5, Report.

Proposed by *Mr. Rendel*, seconded by *General Taylor*, First, That the following words, "and keep the guns in efficient repair," be omitted ; and secondly, that the words, "and therefore not to be compared to them in this important respect in efficiency for active service."

The first motion lost, as there was no seconder.

Amendment.—Proposed by *Captain Singer*, seconded by *Colonel Simmons*, That the last two lines of the paragraph run as follows :—"and cannot be compared to them in this important respect in efficiency for active service."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Captain Singer.  | Major Young.    |
| Colonel Simmons. | Mr. Rendel.     |
| Colonel Ormsby.  | Captain Wilson. |
| Mr. McDonald.    | General Taylor. |
| General Rumley.  |                 |

Page 41, paragraph 3, Draft ; now page xxxii., paragraph 6, Report.

Proposed by *Major Young*, seconded by *Mr. Rendel*, That after the words "they have to report that," the paragraph run as follows :—"that there is no material difference in simplicity of construction."

Amendment.—Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the word "very" be added before "material."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Simmons. | Major Young.    |
| Colonel Ormsby.  | Mr. Rendel.     |
| Captain Singer.  | Captain Wilson. |
| General Taylor.  |                 |
| General Rumley.  |                 |
| Mr. McDonald.    |                 |

109, Victoria Street, Westminster, April 6, 1865.

#### MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President.*

MAJOR-GENERAL TAYLOR, R.A.

MAJOR YOUNG, R.A.

COLONEL ORMSBY, R.A.

MR. STUART RENDEL.

CAPTAIN WILSON, R.N.

MR. McDONALD.

CAPTAIN SINGER, R.N.

MAJOR DYER, R.A., *Secretary.*

Page 41, paragraph 3, Draft ; now page xxxii., paragraph 6, Report.

Proposed by *Mr. McDonald*, seconded by *Colonel Ormsby*, That the following be inserted in continuation of the paragraph :—"the Whitworth gun, however, is manufactured of one material (except the trunnion ring), has a like section of bore throughout ; whereas the Armstrong muzzle-loader is made of two materials, has a special powder chamber, and besides the shunt arrangement, the grooves have inclines towards the muzzle, which makes the section of the bore vary."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Mr. McDonald.    | Major Young.    |
| Colonel Ormsby.  | Captain Singer. |
| Colonel Simmons. | Mr. Rendel.     |
| General Taylor.  | Captain Wilson. |
| General Rumley.  |                 |

Page 41, paragraph 5, Draft ; now page xxxii., paragraph 8, Report.

Proposed by *Mr. Rendel*, That the prices be omitted. Not seconded.

Page 41, paragraph 6, Draft ; now page xxxii., last paragraph, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following words be added :—"in this opinion the Committee quite concur."

Carried *Nem. con.*



Page 41, last paragraph, Draft; now page xxxiii, first paragraph, Report.

Proposed by *Major Young*, seconded by *Mr. Rendel*, That the following words be omitted:—"if anything, there is rather less work on the Whitworth, which probably is compensated by its being a hundredweight heavier, and having more steel in it."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Major Young.    | Colonel Ormsby.  |
| Mr. Rendel.     | Colonel Simmons. |
| Captain Wilson. | Captain Singer.  |
|                 | General Taylor.  |
|                 | Mr. McDonald.    |

Page 42, paragraph 6, Draft; now page xxxiii, paragraph 7, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That the following be substituted for the last portion of the paragraph:—"being of opinion that the projectiles for his breech-loading gun were too high gauge for the steel barrel, which was found to expand less than the coil barrels ordinarily used, requested that a number of rounds might be fired with both undercut and zincd projectiles of a reduced gauge."

Amendment.—Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the paragraph end as follows:—"with projectiles of a reduced gauge, in some of which the lead was attached by the zinc process, and in others by the undercut process, which he considered might take the grooving better than the zincd projectiles."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Simmons. | Major Young.    |
| Colonel Ormsby.  | Captain Singer. |
| General Taylor.  | Captain Wilson. |
| General Rumley.  |                 |

Page 42, paragraph 7, Draft; now page xxxiii, paragraph 7, Report.

Proposed by *Mr. Rendel*, seconded by *General Taylor*, That this paragraph be omitted.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Ormsby.  |
| General Taylor. | Colonel Simmons. |
|                 | Major Young.     |
|                 | Captain Singer.  |
|                 | Captain Wilson.  |
|                 | Mr. McDonald.    |

Page 45, paragraph 2, Draft; now page xxxv., paragraph 12, Report.

Proposed by *Major Young*, seconded by *Captain Singer*, That this paragraph stand.

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Major Young.     | Mr. Rendel.     |
| Captain Singer.  | Captain Wilson. |
| Colonel Ormsby.  | General Taylor. |
| Colonel Simmons. |                 |
| Mr. McDonald.    |                 |

109, Victoria Street, Westminster, April 7, 1865.

MEMBERS PRESENT :

|                                         |                                     |
|-----------------------------------------|-------------------------------------|
| MAJOR-GENERAL RUMLEY, <i>President.</i> |                                     |
| MAJOR-GENERAL TAYLOR, R.A.              | CAPTAIN SINGER, R.N.                |
| COLONEL ORMSBY, R.A.                    | MAJOR YOUNG, R.A.                   |
| CAPTAIN WILSON, R.N.                    | MR. STUART RENDEL.                  |
| COLONEL SIMMONS, C.B., R.E.             | MR. McDONALD.                       |
|                                         | MAJOR DYER, R.A., <i>Secretary.</i> |

Page 45, after paragraph 2, Draft; now page xxxv., after last paragraph, Report.

Proposed by *Mr. Rendel*, seconded by *General Taylor*, The following paragraph:—"But it appears that Sir W. Armstrong was under the impression that the experiment was made with the sole view of exhibiting the maximum effect of the shells on the entire column."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Ormsby.  |
| General Taylor. | Colonel Simmons. |
|                 | Major Young.     |
|                 | Captain Singer.  |
|                 | Captain Wilson.  |
|                 | Mr. McDonald.    |

Page 45, after last paragraph, Draft ; now page xxxvi, after paragraph 7, Report.

Proposed by *Mr. Rendel*, seconded by *Major Young*, That a further description of segment shell appear.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Ormsby.  |
| Major Young.    | Colonel Simmons. |
| Captain Singer. | Captain Wilson.  |
| General Taylor. | Mr. McDonald.    |
|                 | General Rumley.  |

Page 47, Draft ; now page xxxvii, Report.

Proposed by *Mr. Rendel*, seconded by *Major Young*, That a paragraph relative to the hits be inserted.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Ormsby.  |
| Major Young.    | Colonel Simmons. |
| Captain Singer. | Captain Wilson.  |
| General Taylor. | Mr. McDonald.    |
|                 | General Rumley.  |

Page 47, line 25, Draft ; now page xxxvii, line 18, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That the following words be inserted after the word "fired" :—"with time fuze."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Ormsby.  |
| Captain Singer. | Colonel Simmons. |
| Major Young.    | Mr. McDonald.    |
| Captain Wilson. |                  |
| General Taylor. |                  |

Page 48, paragraph 4, Draft ; now page xxxviii, paragraph 4, Report.

Proposed by *Mr. Rendel*, That this paragraph be omitted

Amendment.—Proposed by *Major Young*, seconded by *Colonel Simmons*, "That the paragraph run as follows :—That the shrapnel shell is in principle a more, &c."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Major Young.     | Captain Singer. |
| Colonel Simmons. | Mr. Rendel.     |
| Colonel Ormsby.  | Captain Wilson. |
|                  | General Taylor. |

109, Victoria Street, Westminster, April 10, 1865.

#### MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President.*

|                             |                                     |
|-----------------------------|-------------------------------------|
| MAJOR-GENERAL TAYLOR, R.A.  | CAPTAIN SINGER, R.N.                |
| COLONEL ORMSBY, R.A.        | MAJOR YOUNG, R.A.                   |
| CAPTAIN WILSON, R.N.        | MR. STUART RENDEL.                  |
| COLONEL SIMMONS, C.B., R.E. | MR. McDONALD.                       |
|                             | MAJOR DYER, R.A., <i>Secretary.</i> |

In continuation of the proceedings of the 7th instant,—

Amendment to *Mr. Rendel's* motion :—Proposed by *General Taylor*, That the paragraph run as follows :—"Upon reviewing the whole of the practice with Sir W. Armstrong's segment and Colonel Boxer's shrapnel shell, as fired from Mr. Whitworth's gun, the Committee is of opinion that when used with the time fuze and burst in the air, the greater penetrative effects of the bullets give a decided preference to Colonel Boxer's shrapnel shell, but this projectile has produced very inferior results to those of the segment shell when burst by striking on the ground, while the latter possess the advantage of being capable of being fired with both fuzes."

Page 48, Draft ; now page xxxviii, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, before voting on the above, That the following paragraph be inserted :—"The Committee, however, consider that the form of the Whitworth projectile is unfavourable to exhibiting the full efficiency of Colonel Boxer's shrapnel shell when burst on graze."



The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Ormsby.  |
| Captain Singer. | Colonel Simmons. |
| Major Young.    | Captain Wilson.  |
| General Taylor. | Mr. McDonald.    |
|                 | General Rumley.  |

Same proposer, That the paragraph run as follows :—" As it appeared also that in the practice recorded above for range and accuracy 18 out of the 112 shrapnel shells broke up in the bore of the Whitworth gun, and that in firing at targets at 2,600 yards, 11 out of 20 broke up on graze, the Committee consider that these projectiles, as submitted to them, are not sufficiently strong."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Mr. Rendel.      | Captain Wilson. |
| Captain Singer.  |                 |
| Colonel Ormsby.  |                 |
| Colonel Simmons. |                 |
| Major Young.     |                 |
| General Taylor.  |                 |

Amendment to *General Taylor's* motion.—Proposed by *Captain Singer*, seconded by *Major Young*, That the paragraph run as follows :—" Upon reviewing the whole of the practice with Sir W. Armstrong's segment, and Colonel Boxer's shrapnel shells, and taking into due consideration the fact that the principle of the shrapnel shell is not confined to the form of shell used in the Committee's experiments, but may be applied to any form of projectile, also that the description of fuze best adapted for ricochet practice may be used with it, the Committee are of opinion that the shrapnel shell is the more formidable projectile of the two."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Captain Singer.  | Mr. Rendel.     |
| Major Young.     | Captain Wilson. |
| Colonel Ormsby.  | General Taylor. |
| Colonel Simmons. |                 |
| Mr. McDonald.    |                 |

109, Victoria Street, Westminster, April 11, 1865.

MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President.*

|                             |                      |
|-----------------------------|----------------------|
| MAJOR-GENERAL TAYLOR, R.A.  | CAPTAIN SINGER, R.N. |
| COLONEL ORMSBY, R.A.        | MAJOR YOUNG, R.A.    |
| CAPTAIN WILSON, R.N.        | MR. STUART RENDEL.   |
| COLONEL SIMMONS, C.B., R.E. | MR. McDONALD.        |

MAJOR DYER, R.A., *Secretary.*

Page 52, last paragraph, Draft ; now page xlii., last paragraph, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following be substituted for this paragraph :—" The Committee have further to report that they consider that Sir W. Armstrong's percussion fuze gave on the whole most satisfactory results, and Colonel Boxer's percussion fuze satisfactory results on water, and against upright obstacles, but not satisfactory results on graze, which latter they consider, in some respect, probably due to the form of the projectile ; and having considered the construction of the fuze, and the entire subject in all its bearings, they are of opinion that there is no decided superiority in one fuze over the other."

Carried, *Mr. Rendel* not voting.

Amendment.—Proposed by *Mr. Rendel*, not seconded.—" Upon the whole the Committee have not thought it necessary, as between Sir W. Armstrong and Mr. Whitworth, to extend their investigations into the question of time fuzes so far as to enable them to express a decided opinion upon the relative value of the fuzes submitted to them."

Page 49, before paragraph 5, Draft ; now page xxxix., paragraph 6, Report.

Proposed by *Mr. Rendel*, That the following paragraph be inserted :—" With respect to the stripping of the lead from the projectile of the B.-L. Armstrong gun, referred to in the evidence, the Committee have to report that, except when fired continuously without either lubricators or water, no such liability has been observed during their experiments."

Amendment.—Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the words "referred to in the evidence" and the word "continuously" be omitted.

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Simmons. | Major Young.    |
| Colonel Ormsby.  | Captain Singer. |
| Captain Wilson.  | Mr. Rendel.     |
| General Taylor.  |                 |

Proposed.—Are the Committee to enter upon a discussion with a view of expressing a general opinion upon the merits of the respective systems of ordnance submitted for their examination.

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Ormsby.  | General Taylor. |
| Colonel Simmons. |                 |
| Major Young.     |                 |
| Captain Singer.  |                 |
| Captain Wilson.  |                 |

109, Victoria Street, Westminster, April 13, 1865.

MEMBERS PRESENT:

MAJOR-GENERAL RUMLEY, *President.*

|                             |                                     |
|-----------------------------|-------------------------------------|
| MAJOR-GENERAL TAYLOR, R.A.  | CAPTAIN SINGER, R.N.                |
| COLONEL ORMSBY, R.A.        | MAJOR YOUNG, R.A.                   |
| CAPTAIN WILSON, R.N.        | MR. STUART RENDEL.                  |
| COLONEL SIMMONS, C.B., R.E. | MR. McDONALD.                       |
|                             | MAJOR DYER, R.A., <i>Secretary.</i> |

In continuation of the proceedings of 11th instant.

Page 52, last paragraph, Draft ; now page xlii., last paragraph, Report.

Proposed by *General Taylor*, seconded by *Captain Wilson*, That the last portion of *Captain Singer's* motion be omitted.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| General Taylor. | Colonel Ormsby.  |
| Captain Wilson. | Colonel Simmons. |
| Mr. Rendel.     | Captain Singer.  |
|                 | Major Young.     |
|                 | Mr. McDonald.    |

109, Victoria Street, Westminster, April 18, 1865.

MEMBERS PRESENT:

MAJOR-GENERAL RUMLEY, *President.*

|                             |                                     |
|-----------------------------|-------------------------------------|
| MAJOR-GENERAL TAYLOR, R.A.  | CAPTAIN SINGER, R.N.                |
| COLONEL ORMSBY, R.A.        | MAJOR YOUNG, R.A.                   |
| CAPTAIN WILSON, R.N.        | MR. STUART RENDEL.                  |
| COLONEL SIMMONS, C.B., R.E. | MR. McDONALD.                       |
|                             | MAJOR DYER, R.A., <i>Secretary.</i> |

Paragraph 1 (summing up), Draft ; now page xliii., paragraph 1, Report.

Proposed by *Captain Wilson*, seconded by *Captain Singer*, That the words "very far" be omitted.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Captain Wilson. | Colonel Simmons. |
| Captain Singer. | Colonel Ormsby.  |
| Mr. Rendel.     | Major Young.     |
| General Taylor. | Mr. McDonald.    |
|                 | General Rumley.  |

Paragraph 1 (summing up), Draft ; now page xliii., paragraph 1, Report.

Proposed by *Captain Wilson*, seconded by *Mr. McDonald*, That the portion relative to boats in this paragraph be omitted.



The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Captain Wilson. | Colonel Ormsby.  |
| Mr. McDonald.   | Colonel Simmons. |
|                 | Major Young.     |
|                 | Mr. Rendel.      |
|                 | Captain Singer.  |
|                 | General Taylor.  |

First paragraph carried.

Amendment.—Proposed by *General Taylor*, not seconded, That the latter portion of the paragraph from the words “they are of opinion” to the end be omitted, and in lieu thereof the following be inserted:—“That after a careful weighing of all the considerations involved, the balance of advantage rests with the two muzzle-loading guns, but they think it due in summing up to record their recognition of the following advantages attaching to Sir W. Armstrong’s B.-L. 12-pr. as submitted.

“1st. Its lightness, being half cwt. lighter than the shunt, and  $1\frac{1}{2}$  cwt. lighter than Mr. Whitworth’s.

“2nd. Its greater adaptability, for this and other reasons before detailed, for boat service.

“3rd. The facility its construction affords for constantly watching the state of the interior of the bore, an undoubted necessity of rifled guns, and involving with muzzle-loaders a somewhat troublesome process in the field.

“4th. The impossibility of spiking it by an enemy in temporary possession of it, while the removal of the vent-piece renders it to him as useless as if spiked.”

Paragraph 2 (summing up), Draft ; now page xliii., paragraph 2, Report.

Proposed by *Mr. Rendel*, seconded by *General Taylor*, That the description of projectiles be as follows:—“Iron projectiles fitting the rifling mechanically as compared with projectiles fitting the rifling by the compression of soft metal studs.”

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Ormsby.  |
| General Taylor. | Major Young.     |
| Captain Singer. | Colonel Simmons. |
| Captain Wilson. | Mr. McDonald.    |
|                 | General Rumley.  |

Paragraph 4 (summing up), Draft ; now page xliii., paragraph 4, Report.

Proposed by *Captain Singer*, seconded by *Captain Wilson*, That with reference to the paragraph on rifling, it run as follows:—“With respect to form of bore, that both forms are practically sufficient for producing the required rotatory motion.”

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Captain Singer. | Colonel Simmons. |
| Captain Wilson. | Colonel Ormsby.  |
| Major Young.    | General Taylor.  |
| Mr. Rendel.     | Mr. McDonald.    |
|                 | General Rumley.  |

Amendment.—Proposed by *Mr. McDonald*, “With respect to the form of bore, that the Whitworth is more simple and uniform, and that it gives a much larger bearing surface available for rifling duty than the Armstrong muzzle-loader.”

Amendment.—Proposed by *Major Young*, seconded by *General Taylor*, “With respect to the form of bore, Mr. Whitworth has shown that with the hexagonal bore he can obtain a long range and all accuracy that could be desired. Still the Committee cannot lose sight of the fact, that it is not a form such as with a given calibre can be expected to give the maximum results with shells, the greater the deviation from the cylinder the more reduction in the capacity of the shell, and further, that the angles which such a figure presents must assuredly give lines of weakness to both gun and projectiles; both systems answered well as far as their capability of giving a required rotatory motion to the projectiles.”

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Major Young.    | Colonel Simmons. |
| General Taylor. | Colonel Ormsby.  |
| Mr. Rendel.     | Captain Singer.  |
|                 | Captain Wilson.  |
|                 | Mr. McDonald.    |

Amendment.—Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That a verbal alteration in original paragraph be made thus:—“are practically sufficient” instead of “answer perfectly.”

Carried *Nem. con.*

Paragraph 5 (summing up), Draft ; now page xliii., paragraph 5, Report.

Proposed by *Major Young*, seconded by *Mr. Rendel*, With respect to rapidity of twist, that the following be added to this paragraph :—"That for obvious reasons it is not desirable to give a greater twist in a rifled gun than is absolutely necessary to ensure accuracy of flight of the projectile."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Major Young.    | Colonel Simmons. |
| Mr. Rendel.     | Colonel Ormsby.  |
| General Taylor. | Captain Singer.  |
|                 | Captain Wilson.  |
|                 | Mr. McDonald.    |

Amendment.—Proposed by *Mr. McDonald*, not seconded, "That while the twist in the rifling of the muzzle-loading Armstrong has been proved to be sufficient to ensure accuracy within the limits of range hitherto deemed requisite in field service, that of the Whitworth is 100 per cent. greater, and without any detriment to the endurance of his gun, extends its accuracy to ranges at which the same precision is not attainable with the Armstrong muzzle-loader."

Paragraph 7 (summing up), Draft ; now page xliii., paragraph 7, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, With respect to weight of guns, that the paragraph run as follows :—"That the guns proposed by Mr. Whitworth are heavier than those of like power proposed by Sir W. Armstrong. This apparent necessity for increased weight is of considerable moment when considering guns for field service."

Amendment.—Proposed by *Captain Wilson*, seconded by *General Taylor*, "That the Armstrong muzzle-loading gun is  $8\frac{1}{4}$  inches shorter and one cwt. lighter than the Whitworth gun."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Captain Wilson.  | Major Young.    |
| General Taylor.  | Captain Singer. |
| Colonel Simmons. | Mr. Rendel.     |
| Colonel Ormsby.  |                 |
| Mr. McDonald.    |                 |

Proposed by *Mr. Rendel*, seconded by *Major Young*, That the following words be added to the above paragraph :—"and is so far more handy for service."

Carried *Nem. con.*

Paragraph 4 (summing up), Draft ; now page xliii., paragraph 4, Report.

Proposed by *Mr. Rendel*, seconded by *Major Young*, With respect to the form of bore and projectile, that the following paragraph be inserted :—"On the other hand the soft metal studs involve a less departure from the cylindrical or strongest and most serviceable form of bore, empowers the use of the cylindrical or strongest and most capacious form of projectile, wears the bore less, and is thus more applicable on emergency or for economy to guns of wrought iron or brass, provides the projectile with a power of self-adjustment, rendering it more independent of errors of manufacture and of accidental obstruction in the bore."

109, Victoria Street, Westminster, April 19, 1865.

#### MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President.*

|                             |                                     |
|-----------------------------|-------------------------------------|
| MAJOR-GENERAL TAYLOR, R.A.  | CAPTAIN SINGER, R.N.                |
| COLONEL ORMSBY, R.A.        | MAJOR YOUNG, R.A.                   |
| CAPTAIN WILSON, R.N.        | MR. STUART RENDEL.                  |
| COLONEL SIMMONS, C.B., R.E. | MR. McDONALD.                       |
|                             | MAJOR DYER, R.A., <i>Secretary.</i> |

In continuation of the proceedings of the 18th inst.,

*Mr. Rendel's* motion was discussed.

Agreed that the motion be divided and taken by paragraphs.

1st paragraph :—"On the other hand, the soft metal studs involve a less departure from the cylindrical form of bore."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Simmons. |
| Major Young.    | Colonel Ormsby.  |
| General Taylor. | Captain Wilson.  |
| Captain Singer. | Mr. McDonald.    |
|                 | General Rumley.  |



2nd paragraph:—"On the other hand, the system of soft metal studs empowers the use of the cylindrical or most capacious form of projectile."

Amendment.—Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the following words be added:—"which, however, in field guns is of no great importance."

Carried *Nem. con.*

3rd paragraph:—"causes less wear in wrought-iron bores."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Simmons. |
| Major Young.    | Colonel Ormsby.  |
| Captain Singer. | General Taylor.  |
|                 | Mr. McDonald.    |
|                 | Captain Wilson.  |

4th paragraph:—"provides the projectile with a certain power of self-adjustment, rendering it more independent of errors in manufacture and of accidental obstructions in the bore."

Amendment.—Proposed by *Colonel Ormsby*, seconded by *Colonel Simmons*, That the last portion of the paragraph be omitted, viz.:—"rendering it more independent of errors in manufacture and of accidental obstructions in the bore."

Carried *Nem. con.*

Proposed by *Mr. Rendel*, seconded by *Major Young*, That the following be substituted for the last portion of the paragraph in question:—"by which danger from errors of manufacture or accidental obstructions in the bore is to a certain extent avoided."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Simmons. |
| Major Young.    | Colonel Ormsby.  |
| General Taylor. | Captain Wilson.  |
| Captain Singer. | Mr. McDonald.    |
|                 | General Rumley.  |

Paragraph 4 (summing up), Draft; now page xliii., paragraph 4, Report.

Proposed by *Captain Singer*, seconded by *General Taylor*, That the following paragraph be omitted:—"The Committee therefore do not hesitate to recommend the adoption of a system by which projectiles formed of one simple metal can be used."

Amendment.—Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the following paragraph be substituted:—"The Committee, therefore, of the two systems would prefer that in which the projectiles are formed of one simple metal."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Simmons. | Major Young.    |
| Colonel Ormsby.  | Mr. Rendel.     |
| Captain Wilson.  | Captain Singer. |
| Mr. McDonald.    | General Taylor. |
| General Rumley.  |                 |

Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the above vote, having been taken under a misapprehension of its precise signification, be cancelled.

Carried *Nem. con.*

Amendment to *Captain Singer's* motion.—Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the following paragraph be substituted:—"On the whole, the Committee are of opinion that of the two projectiles that which is of one simple metal is to be preferred."

Carried *Nem. con.*

Addition, proposed by *Major Young*, seconded by *Captain Singer*, That the following words be inserted after the word "whole":—"other things being equal."

Carried *Nem. con.*

Paragraph 10 (summing up), Draft; now page xliii., last paragraph, Report.

Proposed by *Mr. McDonald*, seconded by *General Taylor*, That the word "rather" be omitted.

Carried *Nem. con.*

Same paragraph, proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That after the words "interior of a gun" the following words be inserted:—"and that it possesses great advantages when so used."

Carried *Nem. con.*

Paragraph 11 (summing up), Draft; now page xliv., paragraph 1, Report.

Proposed by *Mr. McDonald*, That the following be inserted:—"can be made superior to any other hitherto available for obtaining a maximum strength in guns."

Amendment.—Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That in the above paragraph the following words be inserted after the word "hesitate":—"in the present condition of the manufacture of steel."

Carried *Nem. con.*

Last paragraph, Draft; last paragraph, Report.

Proposed by *Mr. McDonald*, seconded by *General Taylor*, The following paragraph:—"The whole question of material, however, embraces so many considerations of safety, strength, simplicity, economy, certainty in manufacture, and even of progressive improvement, that the Committee cannot at present pronounce more categorically on this head."

Carried *Nem. con.*

Proposed by *Captain Singer*, seconded by *Colonel Simmons*, That the Report terminate here.

Amendment.—Proposed by *General Taylor*, That the following paragraph be added:—"The Committee have to observe that the results of their experiments go to prove that Colonel Boxer's shrapnel, when burst by time fuze in the air during flight, especially at distances considerably short of the object, has a decided advantage over Sir W. Armstrong's segment shell as regards the penetrative power of the bullets it contains and their further range after release, but that this projectile fired to graze in front of an object whenever burst has produced very inferior results to those of Sir W. Armstrong's segment shell burst as he proposes, and may be said to have failed in this respect altogether; while the number of cases in which these projectiles have grazed at short ranges, without exploding at all, show that from causes which may have reference only to the external form of the shell, and may or may not be remediable, their action in this respect in combination with Mr. Whitworth's gun, is not in their present condition effective for field service."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| General Taylor. | Colonel Simmons. |
| Mr. Rendel.     | Colonel Ormsby.  |
| Major Young.    | Captain Singer.  |
|                 | Captain Wilson.  |
|                 | Mr. McDonald.    |

109, Victoria Street, Westminster, June 16, 1865.

#### MEMBERS PRESENT:

MAJOR-GENERAL RUMLEY, *President.*

|                             |                                     |
|-----------------------------|-------------------------------------|
| MAJOR-GENERAL TAYLOR, R.A.  | CAPTAIN SINGER, R.N.                |
| COLONEL ORMSBY, R.A.        | MAJOR YOUNG, R.A.                   |
| CAPTAIN WILSON, R.N.        | MR. McDONALD.                       |
| COLONEL SIMMONS, R.E., C.B. | MR. STUART RENDEL.                  |
|                             | MAJOR DYER, R.A., <i>Secretary.</i> |

The Draft Report was read.

Page 1, lines 28 to 36, Draft; now page li., lines 17 to 21, Report.

Proposed by *Captain Singer*, seconded by *General Taylor*, That the lines commencing "rejected the gun with the coil barrel" be omitted, and the following substituted:—"stated to the Committee that he considered that the trial for endurance would be more satisfactory if carried out with the gun having the thick steel barrel; the Committee had consequently no opportunity of testing for endurance the merits of barrels composed of wrought-iron coils."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Captain Singer. | Colonel Ormsby.  |
| General Taylor. | Colonel Simmons. |
| Mr. Rendel.     | Mr. McDonald.    |
| Captain Wilson. |                  |
| Major Young.    |                  |

Page 1, paragraph 6, Draft; now page li., after paragraph 5, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That this paragraph be omitted.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Captain Singer. | Mr. McDonald.    |
| Major Young.    | Colonel Simmons. |
| Colonel Ormsby. |                  |
| Mr. Rendel.     |                  |
| Captain Wilson. |                  |
| General Taylor. |                  |



Page 1, lines 47 to 54, Draft ; now page li., lines 25 to 28, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That these lines be omitted and the following substituted :—"As an example of the correctness of the view expressed by Sir W. Armstrong, that the side wedge loading system is preferable for all large breech-loading guns, and of the great inconvenience arising from the use of the shifting vent-piece when applied to heavy guns the Committee have to report."

The Committee divided.

| <i>For.</i>     | <i>Against.</i> |
|-----------------|-----------------|
| Captain Singer. | Mr. McDonald.   |
| Major Young.    |                 |
| Colonel Ormsby. |                 |
| Mr. Rendel.     |                 |
| General Taylor. |                 |
| Captain Wilson. |                 |

Page 1, paragraph 7, Draft ; now page li., paragraph 6, Report.

Proposed by *Major Young*, seconded by *General Taylor*, That the latter portion of this paragraph, running as follows, be omitted :—"in loading a 7-inch breech-loading gun in consequence of the jamming of the vent-piece ; these delays were in their opinion quite sufficient to satisfy them as to the propriety of excluding the breech-loading gun with shifting vent-piece from the competition either with Sir W. Armstrong's wedge system of breech-loading artillery, or with his or Mr. Whitworth's muzzle-loading systems."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Major Young.    | Colonel Simmons. |
| General Taylor. | Mr. McDonald.    |
| Mr. Rendel.     |                  |
| Colonel Ormsby. |                  |
| Captain Singer. |                  |
| Captain Wilson. |                  |

Page 2, lines 32, 33, and 34, Draft ; now page li., paragraph 8, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That in place of these words, "and all the practice which had been made from the upper vent was repeated from the rear vent," the following lines be substituted :—"As, however, the Committee considered it necessary that Mr. Whitworth should adhere in the trial of his system to one mode of venting his 70-pounder guns, all the practice which had been made from the upper vent was repeated from the rear vent, and the trials for endurance were transferred to another gun in which the rear vent was used exclusively."

Carried *Nem. con.*

Page 2, line 36, Draft ; now page lii., line 4, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following line be inserted :—"found necessary in order to obtain the same range as from the top vent."

Carried *Nem. con.*

Page 2, lines 42 and 43, Draft ; now page lii., after line 8, Report.

Proposed by *Major Young*, seconded by *Mr. Rendel*, That the following words be omitted :—"with plane surfaces and no intervening substance."

The Committee divided.

| <i>For.</i>     | <i>Against.</i> |
|-----------------|-----------------|
| Major Young.    | Captain Singer. |
| Mr. Rendel.     | Mr. McDonald.   |
| Colonel Ormsby. |                 |
| Captain Wilson. |                 |
| General Taylor. |                 |

109, Victoria Street, Westminster, June 17, 1865.

MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President.*

|                             |                                     |
|-----------------------------|-------------------------------------|
| MAJOR-GENERAL TAYLOR, R.A.  | CAPTAIN SINGER, R.N.                |
| COLONEL ORMSBY, R.A.        | MAJOR YOUNG, R.A.                   |
| CAPTAIN WILSON, R.N.        | MR. STUART RENDEL.                  |
| COLONEL SIMMONS, R.E., C.B. | MR. McDONALD.                       |
|                             | MAJOR DYER, R.A., <i>Secretary.</i> |

Page 3, line 52, Draft ; now page lii., line 60, Report.

Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That as it appears that there is a doubt as to the correctness of the record of the practice on the 27th and 28th October 1864, at 15°

of elevation, this practice be not taken into consideration in discussing the Report, and that the result of the practice of the guns at 15°, which are to be fired hereafter at Shoeburyness, only be taken into consideration.

Amendment.—Proposed by *General Taylor*, seconded by \_\_\_\_\_, That the record remain with an explanation stating that, not being considered satisfactory, the practice be repeated.

Amendment.—Proposed by *Major Young*, seconded by *Captain Singer*, That these results should appear in the table of accuracy, with a foot-note stating that there was apparently an error in the recorded elevation.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Major Young.    | Colonel Ormsby.  |
| Captain Singer. | Colonel Simmons. |
| Mr. Rendel.     | Mr. McDonald.    |
| Captain Wilson. |                  |
| General Taylor. |                  |

Page 3, table, Draft ; now page lii., table, Report.

Proposed by *General Rumley*, seconded by *Colonel Ormsby*, That the word “solid” in the heading of this table be omitted.

Carried *Nem. con.*

Pages 4 and 5, after tables, Draft ; now pages liii. and liv., after tables, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That instead of the sums of the errors being taken, it should be sums of the ratios of the mean errors ; and a similar correction made in the 12-pounder report to correspond.

Carried *Nem. con.*

Page 7, after line 43, Draft ; now page lvi., after paragraph 1, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following be inserted at the end of the article on initial velocity:—“and that this fact renders the muzzle-loading Armstrong a more powerful gun at short ranges.”

Amendment.—Proposed by *Colonel Ormsby*, seconded by *Colonel Simmons*, That the consideration of this question be postponed to the end of the Report.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Ormsby.  | Major Young.    |
| Colonel Simmons. | Captain Singer. |
| Captain Wilson.  | Mr. Rendel.     |
| General Taylor.  |                 |
| Mr. McDonald.    |                 |

Page 8, Draft, to the end of the article on accuracy ; now pages lvii. and lviii., Report, to the end of the article on accuracy.

This portion of the article on accuracy to be discussed hereafter when *Captain Singer's* proposal has been distributed to the members, *Captain Singer's* proposal being an amendment to the draft on accuracy.

Page 11, line 23, Draft ; now page lix., lines 44 and 45, Report.

Proposed by *General Taylor*, seconded by *Captain Singer*, That the following be inserted :—“the muzzle-loader Armstrong shell being found unbroken inside, and the Whitworth shell in pieces.”

Carried *Nem. con.*

Page 11, paragraph 4, Draft ; now page lix., paragraph 10, Report.

Proposed by *Captain Singer*, seconded by *Mr. Rendel*, That the following paragraph be substituted :—“A shot from each gun struck on the solid part of the tower where the brickwork is about 40 feet thick ; the hollow-headed shot of the breech-loading Armstrong gun penetrated 3 feet ; the solid shot from the Whitworth gun passed through 7·25 feet of brickwork, having deflected downwards and broken through the crown of the arch ; the hollow-headed shot from the muzzle-loading Armstrong gun penetrated 4·75 feet.”

Carried *Nem. con.*

Page 12, after line 23, Draft ; now page lx., paragraphs 7 and 8, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Wilson*, That the following paragraphs be inserted :—“In consequence of a delay in the arrival of the Whitworth cartridges, 40 rounds of ‘independent,’ and 40 rounds of ‘quick’ firing were completed by the Armstrong guns before the Whitworth gun took up the firing.”

“This gave an advantage to the Whitworth gun, as the men advanced in smartness as the firing proceeded.”

Carried *Nem. con.*



109, Victoria Street, Westminster, June 19, 1865.

MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President.*

MAJOR-GENERAL TAYLOR, R.A.

COLONEL ORMSBY, R.A.

CAPTAIN WILSON, R.N.

COLONEL SIMMONS, R.E., C.B.

CAPTAIN SINGER, R.N.

MAJOR YOUNG, R.A.

MR. STUART RENDEL.

MAJOR DYER, R.A., *Secretary.*

Page 13, after paragraph 3, Draft ; now page lxi., paragraph 4, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That the following paragraph be inserted :—“As circumstances might arise on service when guns would have to be fired without lubrication, the Committee caused the guns to be tested with 20 rounds of rapid fire without lubrication ; the muzzle-loading Armstrong gun exhibited a considerable superiority to the Whitworth in this trial. The result accords with that obtained in a similar trial with the 12-pounders.”

Carried *Nem. con.*

Page 13, after paragraph 4, Draft ; now page lxi., paragraph 6, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following paragraph be inserted :—“The Committee have here to remark that the upper or vertical vent has, as before mentioned, the advantage over that in the axis of the gun, inasmuch as with this vent the gun is more readily primed, and there is much less risk of the firing being delayed by the choking of the vent through accumulation of deposit.”

Consideration postponed.

*Mr. Rendel* objected to the practice, page 13, Draft, page lxi., Report, with Whitworth upper vent being considered under the head of rapid firing.

Page 13, after paragraph 10, Draft ; now page lxi., paragraph 12, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following paragraph be inserted :—“Judging, however, from later experiments, especially those carried out on board H.M.S. ‘Excellent,’ where the loading was performed with most perfect ease and with the ordinary service sponge, the Committee are of opinion that the batch of shot used in this experiment must have been of too high gauge.”

Amendment.—Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the word “too” in the last line of this paragraph be omitted.

The Committee divided.

*For.*

Colonel Simmons.

Colonel Ormsby.

General Taylor.

General Rumley.

*Against.*

Major Young.

Captain Singer.

Captain Wilson.

*Mr. Rendel* not voting, owing to *Mr. McDonald's* absence.

Page 13, paragraph 11, Draft ; now page lxi., paragraph 13, Report.

Proposed by *Colonel Simmons*, seconded by *Captain Singer*, That the following paragraphs be substituted for the one in the Draft :—“On another occasion a similar occurrence took place with the Whitworth gun as that above referred to with the Armstrong gun, a shell having jammed about 4 feet from the muzzle, which was only eventually forced down with very great difficulty.”

“Upon consideration of these experiments and the long course of practice they have witnessed with these guns, the Committee are of opinion that the jams above referred to with both guns were exceptional, but with the muzzle-loading Armstrong gun there appears to be a slight risk (especially in the hurry of action) of the projectile being entered on the shallow grooves which would be productive of some delay and inconvenience.”

Amendment.—Proposed by *Major Young*, not seconded, That the following be added :—“The Committee, however, observe that in the whole course of the experiments there are only two instances on record of a delay having occurred from this cause.”

Amendment.—Proposed by *General Taylor*, seconded by *Captain Wilson*, “As regards ease of loading, the only instances of difficulty that have occurred with either gun have been so rare and obviously exceptional that they are unable in summing up to assign to either gun a decided advantage over the other in this respect.”

The Committee divided.

*For.*

General Taylor.

Captain Wilson.

Colonel Ormsby.

Major Young.

*Against.*

Colonel Simmons.

Captain Singer.

*Mr. Rendel* not voting, owing to *Mr. McDonald's* absence.

Proposed by *Captain Wilson*, seconded by *General Taylor*, That the following be added:—"The Committee also observe, that judging from these experiments, they see no reason for preferring the rear to the top vent."

Proposed by *Colonel Ormsby*, seconded by *Colonel Simmons*, That the question be postponed to a later period and considered more fully.

Carried *Nem. con.*

Page 18, Draft; now page lxiv., Report.

Proposed by *Captain Singer*, seconded by *Colonel Ormsby*, That the consideration of the 1st and 2nd paragraphs of this page be postponed until accuracy has been disposed of.

Carried *Nem. con.*

Page 19, paragraph 4, Draft; now page lxiv., paragraph 7, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following be substituted for the last sentence in this paragraph:—"this exemplifies in a marked manner the result obtained by the electro-ballistic pendulum, viz., that the muzzle-loading Armstrong gun is capable of consuming with advantage a 14 lbs. charge."

Carried *Nem. con.*

Page 19, after paragraph 4, Draft; now page lxiv., paragraph 8, Report.

Proposed by *Mr. Rendel*, seconded by *General Taylor*, That the following be added after the words "heavy charges":—"The practice at 10° was very limited in number of rounds, 9 only having been fired, but is the most remarkable in point of accuracy that the Committee have recorded throughout the course of their experiments."

The Committee divided.

*For.*

General Taylor.  
Major Young.  
Captain Singer.  
General Rumley.

*Against.*

Colonel Ormsby.  
Colonel Simmons.  
Captain Wilson.

*Mr. Rendel's* vote not being recorded, as *Mr. McDonald* was not present.

Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the following come in after the above:—"the Committee, however, desire to observe that, considering the abnormal results which are to be found occasionally in their tables of practice, this observation respecting the practice at 10°, which is not fully borne out by that at 7°, must be accepted with reserve; Sir W. Armstrong having proposed 10 lbs. as the ordinary service charge for his gun, and 14 lbs. only as a special charge, the heavier charge of 14 lbs. was only tried for range and accuracy, among the rounds placed at his disposal by the Committee towards the conclusion of their experiments; the Committee, therefore, regret that they had no opportunity of enlarging these experiments, and also of testing the gun for endurance with these charges."

The Committee divided.

*For.*

Colonel Simmons.  
Colonel Ormsby.  
Captain Wilson.  
General Taylor.

*Against.*

Major Young.  
Captain Singer.

109, Victoria Street, Westminster, June 20, 1865.

MEMBERS PRESENT:

MAJOR-GENERAL RUMLEY, *President.*

MAJOR-GENERAL TAYLOR, R.A.  
COLONEL ORMSBY, R.A.  
CAPTAIN WILSON, R.N.  
COLONEL SIMMONS, R.E., C.B.

CAPTAIN SINGER, R.N.  
MAJOR YOUNG, R.A.  
MR. STUART RENDEL.  
MR. McDONALD.  
MAJOR DYER, R.A., *Secretary.*

Page 20, line 12, Draft; now page lxv., line 20, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That the words "into masonry" be inserted after the word "penetration," and that the following be added to the paragraph:—"This observation does not apply to the use of this gun against wooden ships or defences offering but moderate resistance to penetration."

Amendment.—Proposed by *Colonel Simmons*, That the words "into all substances" be substituted for the words "into masonry" in the first part of *Mr. Rendel's* motion.

Carried *Nem. con.*



Page 22, after paragraph 1, Draft; now page lxvi., paragraph 4, Report.

Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the following paragraph be inserted :—"The Committee observe that the capability of Sir W. Armstrong's muzzle-loading gun for throwing shells of such large capacity gives it great destructive powers, which for certain purposes of war must be of very great value, and regret that the fact of these having been brought forward at so late a period of their proceedings has prevented them from firing a larger number of rounds to verify the indications given of the accuracy of its fire herewith."

Amendment.—Proposed by *General Taylor*, seconded by *Captain Wilson*, That the paragraph after the word "value" be omitted.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| General Taylor. | Colonel Ormsby.  |
| Captain Wilson. | Colonel Simmons. |
| Captain Singer. | Mr. McDonald.    |
| Mr. Rendel.     |                  |

Page 24, line 11, Draft; now page lxviii., line 23, Report.

Proposed by *General Taylor*, seconded by *Captain Singer*, That the following words be inserted :—"with the guns now under consideration."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| General Taylor. | Colonel Ormsby.  |
| Captain Singer. | Colonel Simmons. |
| Major Young.    | Mr. McDonald.    |
| Mr. Rendel.     |                  |
| Captain Wilson. |                  |

Page 24, lines 24 to 27, Draft; now page lxviii., lines 38 to 40, Report.

Proposed by *Major Young*, seconded by *Captain Singer*, That the following lines be substituted :—"This liability of the shrapnel shell to break up when fired from the Whitworth gun was also shown in the practice with similar projectiles in the 12-pounder experiments, and as there is no reason to suppose that this breaking up was caused by the shrapnel principle *per se*."

Amendment.—Proposed by *General Taylor*, seconded by *Captain Wilson*, That the following be added to the paragraph :—"but consequent on the want of strength in the projectile itself."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| General Taylor.  | Major Young.    |
| Captain Wilson.  | Captain Singer. |
| Colonel Ormsby.  | Mr. Rendel.     |
| Colonel Simmons. |                 |
| Mr. McDonald.    |                 |

Page 24, lines 41 and 42, Draft; now page lxviii., lines 47 and 48, Report.

Proposed by *General Rumley*, seconded by *Colonel Ormsby*, That the following words be substituted :—"the principle of the shrapnel strongly in preference to that of the segment shell."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| General Rumley.  | General Taylor. |
| Colonel Ormsby.  |                 |
| Colonel Simmons. |                 |
| Major Young.     |                 |
| Captain Wilson.  |                 |
| Captain Singer.  |                 |

*Mr. Rendel* not voting in *Mr. McDonald's* absence.

Amendment.—Proposed by *Captain Wilson*, seconded by *General Taylor*, That the last two lines in Draft above referred to be omitted.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Captain Wilson. | Colonel Ormsby.  |
| General Taylor. | Colonel Simmons. |
|                 | Major Young.     |
|                 | Captain Singer.  |

109, Victoria Street, Westminster, June 23, 1865.

MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President*.

MAJOR-GENERAL TAYLOR, R.A.  
COLONEL ORMSBY, R.A.  
CAPTAIN WILSON, R.N.  
COLONEL SIMMONS, R.E., C.B.

CAPTAIN SINGER, R.N.  
MAJOR YOUNG, R.A.  
MR. McDONALD.  
MR. STUART RENDEL.  
MAJOR DYER, R.A., *Secretary*.

An amendment to the article on accuracy having been proposed by *Captain Singer*, and there being no objection raised, the discussion was proceeded with.

Agreed that a Sub-Committee shall meet to verify the proceedings in reference to the 12-pounder Report.

MEMBERS :

GENERAL TAYLOR.

CAPTAIN WILSON.

Article on accuracy, paragraph 3, line 3, Draft; now article on accuracy, paragraph 3, line 2, Report.

Proposed by *Captain Singer*, seconded by *Colonel Simmons*, That this line run as follows:—"made at successive elevations varying from each other."

Carried *Nem. con.*

With reference to the above,

Proposed by *Mr. McDonald*, seconded by *General Taylor*, That the word "successive" be struck out.

Carried *Nem. con.*

Article on accuracy.

Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the three tables of practice be on the first page immediately following the first paragraph.

Amendment.—Proposed by *Captain Wilson*, seconded by *General Taylor*, That the following be inserted before the second paragraph:—"In these experiments practice was carried on with shot at elevations of 0°, 3°, 6°, 9°, 12°, and 15°; with common shell at 1°, 4°, 7°, and 10°; and with segment or shrapnel shell at 2°, 5°, 8°, and 11°."

The Committee divided.

*For.*

Captain Wilson.  
General Taylor.  
Captain Singer.  
Mr. Rendel.  
General Rumley.

*Against.*

Colonel Ormsby.  
Colonel Simmons.  
Major Young.  
Mr. McDonald.

Article on accuracy.

Proposed by *Major Young*, seconded by *General Taylor*, That the diagrams and paragraphs in connexion with them be omitted.

The Committee divided.

*For.*

Major Young.  
General Taylor.  
Mr. Rendel.  
Captain Wilson.

*Against.*

Colonel Ormsby.  
Colonel Simmons.  
Captain Singer.  
Mr. McDonald.  
General Rumley.

Article on accuracy, page 3, line 3, Draft; now page lvii., line 16, Report.

Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the word "slightly" be inserted.

The Committee divided.

*For.*

Colonel Simmons.  
Colonel Ormsby.  
Mr. McDonald.

*Against.*

Major Young.  
Captain Singer.  
Mr. Rendel.  
Captain Wilson.  
General Taylor.

Article on accuracy, page 3, paragraph 2, Draft; now page lvii., paragraph 2, Report.

Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the following paragraph be substituted:—"From about 1,700 yards up to ranges of from 2,000 to 2,800 yards, the accuracy of the muzzle-loading guns may be considered as about equal."



The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Simmons. | Major Young.    |
| Colonel Ormsby.  | Captain Singer. |
| Mr. McDonald.    | Mr. Rendel.     |
|                  | General Taylor. |
|                  | Captain Wilson. |

With reference to the same paragraph,  
Proposed by *Colonel Ormsby*, seconded by *Mr. McDonald*, That “3,000” be substituted for “3,500.”

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Ormsby.  | Major Young.    |
| Mr. McDonald.    | Captain Singer. |
| Colonel Simmons. | Mr. Rendel.     |
| Captain Wilson.  | General Taylor. |
|                  | General Rumley. |

Article on accuracy, page 4, paragraph 1, Draft ; now page lvii., paragraph 5, Report.  
Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the word “slightly” be inserted.

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Simmons. | Major Young.    |
| Colonel Ormsby.  | Captain Singer. |
| Mr. McDonald.    | Mr. Rendel.     |
|                  | Captain Wilson. |
|                  | General Taylor. |

Article on accuracy, page 5, paragraph 1, Draft ; now page lviii., paragraph 2, Report.  
Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the following be substituted for the last line of this paragraph :—“which, however, it soon loses, as at 1,900 yards and all higher ranges it is far inferior to them both.”

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Simmons. | Major Young.    |
| Colonel Ormsby.  | Captain Singer. |
| Captain Wilson.  | Mr. Rendel.     |
| Mr. McDonald.    |                 |
| General Taylor.  |                 |

Article on accuracy, page 5, paragraph 2, Draft ; now page lviii., paragraph 3, Report.  
Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the words “and 3,500” be omitted.

Amendment.—Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That “3,000” be substituted for “2,500 and 3,500.”

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Ormsby.  |
| Captain Singer. | Colonel Simmons. |
| Major Young.    | Mr. McDonald.    |
| Captain Wilson. |                  |
| General Taylor. |                  |

Page 25, last paragraph, Draft ; now page lxix., paragraph 7, Report.  
Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That the following paragraph be substituted :—“Sir W. Armstrong, considering his breech-loading gun too light for effective use against iron ships of the ‘Warrior’ class, withdrew it from the competition with the muzzle-loading guns in this respect.”

Carried *Nem. con.*

109, Victoria Street, Westminster, June 24, 1865.

## MEMBERS PRESENT:

MAJOR-GENERAL RUMLEY, *President*.

MAJOR-GENERAL TAYLOR, R.A.

COLONEL ORMSBY, R.A.

CAPTAIN WILSON, R.N.

COLONEL SIMMONS, R.E., C.B.

CAPTAIN SINGER, R.N.

MAJOR YOUNG, R.A.

MR. McDONALD.

MR. STUART RENDEL.

MAJOR DYER, R.A., *Secretary*.

Page 27, line 32, Draft; now page lxx., line 28, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following be inserted after the word "iron":—"Notwithstanding the greater work that had to be accomplished by its projectile in consequence of its greater area."

Amendment.—Proposed by *Mr. McDonald*, not seconded, "by virtue of its larger area."

Amendment.—Proposed by *Captain Wilson*, seconded by *General Taylor*, that the original Draft stand.

Amendment.—Proposed by *Captain Singer*, seconded by *Major Young*, That the passage run thus:—"by virtue of its larger calibre, notwithstanding the greater work that had to be accomplished by its projectile."\*

Carried *Nem. con.*

Article on accuracy.

Proposed by *Captain Singer*, seconded by *Colonel Simmons*, A paragraph to finish this article.

Carried *Nem. con.*

Article on accuracy, page 3, paragraph 1, Draft; now page lvii., paragraph 1, Report.

Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That the words "very slightly" be inserted after "muzzle-loading Armstrong gun."

The Committee divided.

*For.*

Colonel Simmons.

Colonel Ormsby.

Mr. McDonald.

*Against.*

Major Young.

Captain Singer.

Mr. Rendel.

Captain Wilson.

General Taylor.

Article on accuracy, page 7, paragraph 1, Draft; now page lviii., paragraph 8, Report.

Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, That in this and the following paragraph "2,000 to 2,800" be substituted for "3,000 and 3,500."

*For.*

Colonel Simmons.

Colonel Ormsby.

Mr. McDonald.

*Against.*

Major Young.

Captain Singer.

Mr. Rendel.

Captain Wilson.

General Taylor.

Page 18, paragraph 1, Draft; now page lxiv., paragraph 1, Report.

Proposed by *Captain Singer*, seconded by *Colonel Ormsby*, That after the word "projectiles," the following be substituted for the remainder of the paragraph:—"with very great but not equal range and accuracy."

Carried *Nem. con.*

Page 27, lines 38, 39, and 40, Draft; now page lxx., lines 31 and 32, Report.

Proposed by *Captain Wilson*, seconded by *Captain Singer*, That the following be substituted for these lines:—"Having been unable to test the accuracy of these projectiles, from the small number of rounds fired at the 'Warrior' target."

Carried *Nem. con.*

Proposed by *Colonel Simmons*, seconded by *Mr. McDonald*, That the following be added to the above:—"and as those rounds gave an indication, especially in the case of the Armstrong gun, with its hollow-headed shot, that the shooting of the guns was different from what it was in the rest of their experiments."

The Committee divided.

*For.*

Colonel Simmons.

Mr. McDonald.

*Against.*

Colonel Ormsby.

Major Young.

Captain Singer.

Mr. Rendel.

Captain Wilson.

General Taylor.



Page 27, paragraph 5, Draft ; now page lxx., paragraph 7, Report.

Proposed by *Major Young*, seconded by *General Taylor*, That the last nine lines, from the word "conducted," be omitted.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Major Young.    | Colonel Ormsby.  |
| General Taylor. | Colonel Simmons. |
| Mr. Rendel.     | Captain Singer.  |
| Captain Wilson. | Mr. McDonald.    |
|                 | General Rumley.  |

Last portion of above paragraph,—

Proposed by *Captain Singer*, seconded by *Colonel Ormsby*, That the words "and accuracy" be inserted after the word "power."

Carried *Nem. con.*

109, Victoria Street, Westminster, July 19, 1865,

MEMBERS PRESENT:

MAJOR-GENERAL RUMLEY, *President.*

|                             |                                     |
|-----------------------------|-------------------------------------|
| COLONEL ORMSBY, R.A.        | MAJOR YOUNG, R.A.                   |
| COLONEL SIMMONS, R.E., C.B. | MR. STUART RENDEL.                  |
| CAPTAIN WILSON, R.N.        | MR. McDONALD.                       |
| CAPTAIN SINGER, R.N.        |                                     |
|                             | MAJOR DYER, R.A., <i>Secretary.</i> |

*Major-General Taylor* was absent through indisposition.

Page 29, lines 39 to 55, Draft ; now page lxxi., last paragraph, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That these lines be substituted by the following :—"In this round the Whitworth shell appears to have obtained greater penetration, and having a larger bursting charge, it might have been expected that its destructive effect on the target would have been superior to that of the Armstrong shell, whereas the destructive effect of the Armstrong shell was decidedly superior to that of the Whitworth."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Captain Singer.  | Mr. McDonald.   |
| Major Young.     |                 |
| Colonel Ormsby.  |                 |
| Colonel Simmons. |                 |
| Mr. Rendel.      |                 |
| Captain Wilson.  |                 |

Proposed by *Captain Singer*, seconded by *Major Young*, That the following be added to the above :—"This the Committee consider must be attributed to the manner in which the shells deliver the effects of their bursting charges, the Armstrong shell acting full to the front which, when the penetration is sufficient, may be considered as the line of least resistance: in the Whitworth shell, on the contrary, except in extreme cases, a large portion of the useful effect of the bursting charge is lost, owing to the base of the shell being blown out as the line of least resistance is in the rear."

Amendment.—Proposed by *Colonel Simmons*, seconded by *Mr. McDonald* :—"The Committee consider that these effects are to be attributed partly to the different manner in which the bursting charges take effect, and partly to the different positions in which the shells were lodged in the target, which is so complicated in its structure that it is difficult to ascribe the precise effects due to the action of shells which do not explode in exactly similar positions."

Amendment.—Proposed by *Mr. Rendel*, seconded by *Colonel Ormsby*, That all following the word "charges" in *Captain Singer's* motion be omitted.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Simmons. |
| Colonel Ormsby. | Captain Wilson.  |
| Major Young.    | Mr. McDonald.    |
| Captain Singer. |                  |

Addition proposed by *Colonel Simmons*, seconded by *Mr. McDonald*, "but is also due partly to the different positions in which the shells were burst."

The Committee divided.

*For.*  
Colonel Simmons.  
Mr. McDonald.

*Against.*  
Colonel Ormsby.  
Major Young.  
Captain Singer.  
Mr. Rendel.  
Captain Wilson.

Page 30, after line 5, Draft; now page lxxii., paragraph 2, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following paragraph be inserted :—"The Whitworth shell struck full on the plate, obtained good penetration, and burst, but the damage done to the target was very trifling."

The Committee divided.

*For.*  
Captain Singer.  
Major Young.  
Colonel Ormsby.  
Colonel Simmons.  
Mr. Rendel.  
Captain Wilson.

*Against.*  
Mr. McDonald.

Page 31, line 55, Draft; now page lxxiii., line 22, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That the following words be inserted :—"except for ricochet."

The Committee divided.

*For.*  
Mr. Rendel.  
Captain Singer.

*Against.*  
Colonel Ormsby.  
Colonel Simmons.  
Major Young.  
Captain Wilson.  
Mr. McDonald.

Page 32, line 18, Draft; now page lxxiii., paragraph 5, Report.

Proposed by *Mr. McDonald*, seconded by *Captain Singer*, That from the above line to the end of the paragraph be omitted.

Carried *Nem. con.*

Page 33, lines 35 to 43, Draft; now page lxxiv., paragraph 1, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following be substituted for the above lines :—"the steel barrel was slightly expanded, but otherwise uninjured; that this crack did not injuriously affect the strength of the gun is shown by 1,430 service rounds, and 102 rounds of excessive charges, for the purpose of breaking up the gun, having been subsequently fired without enlarging the crack, or rendering the gun unserviceable."

Carried *Nem. con.*

109, Victoria Street, Westminster, July 20, 1865.

MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President.*

MAJOR-GENERAL TAYLOR, R.A.  
COLONEL ORMSBY, R.A.  
COLONEL SIMMONS, R.E., C.B.  
CAPTAIN WILSON, R.N.

CAPTAIN SINGER, R.N.  
MAJOR YOUNG, R.A.  
MR. McDONALD.  
MR. STUART RENDEL.  
MAJOR DYER, R.A., *Secretary.*

Page 41, lines 37 to 47, Draft; now page lxxx., after paragraph 3, Report.

Proposed by *Mr. McDonald*, not seconded, That the following be substituted for the above lines :—"On the ground that the rifling of the muzzle-loading Armstrong gun is much more complicated, and therefore much more expensive as well as difficult to execute."

Page 41, line 55, Draft; now page lxxx., line 31, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That after the word "muzzle-loaders" the following be added :—"That of the muzzle-loader being of course fixed, and that of the breech-loader being moveable to admit of loading."

The Committee divided.

*For.*  
Mr. Rendel.  
Captain Singer.  
General Taylor.

*Against.*  
Colonel Ormsby.  
Colonel Simmons.  
Major Young.  
Captain Wilson.  
Mr. McDonald.



Page 42, line 10, Draft; now page lxxx., line 41, Report.

Proposed by *Major Young*, seconded by *Captain Singer*, That the word "coiled" be omitted.

Amendment.—Proposed by *Mr. McDonald*, seconded by *General Taylor*, That after the word "coiled" the following be added, "and piled."

The Committee divided.

*For.*

*Against.*

Mr. McDonald.  
General Taylor.  
Colonel Ormsby.  
Colonel Simmons.  
Captain Wilson.

Major Young.  
Captain Singer.  
Mr. Rendel.

Page 42, lines 30 and 31, Draft; now page lxxx., line 54, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following be omitted:—"and the risk of uncertainty in the welding increases with the size of the hoop."

Carried *Nem. con.*

Page 42, lines 54 to 58, Draft; now page lxxxi., lines 4 to 6, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following be substituted:—"This arrangement apparently answers most perfectly the purpose for which it is intended, viz., of preventing undue longitudinal strain from acting on the welds of the coils."

Amendment.—Proposed by *Captain Wilson*, seconded by *General Taylor*, That the following be added to the end of the paragraph:—"The extraordinary endurance however of this gun when subjected to excessive tests show that this mode of construction gives it more than ample strength."

The Committee divided.

*For.*

*Against.*

Captain Wilson.  
General Taylor.

Colonel Ormsby.  
Colonel Simmons.  
Major Young.  
Captain Singer.  
Mr. Rendel.  
Mr. McDonald.

Amendment.—Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, "This arrangement apparently answers perfectly the purpose for which it is intended, viz., preventing a strain in a longitudinal direction which the coils are less calculated to support."

Carried *Nem. con.*

Page 43, lines 3 and 4, Draft; now page lxxxi., paragraph 2, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following be substituted for the end of this paragraph:—"entirely of this material."

The Committee divided.

*For.*

*Against.*

Captain Singer.  
Major Young.  
Colonel Ormsby.  
Mr. Rendel.  
Captain Wilson.  
General Taylor.

Colonel Simmons.  
Mr. McDonald.

Page 43, lines 24, 25, and 27, Draft; now page lxxxi., lines 21 and 22, Report.

Proposed by *Mr. McDonald*, seconded by *Captain Wilson*, That the following words be omitted:—"possessed such great powers of resistance that it," and the word "actually."

The Committee divided.

*For.*

*Against.*

Mr. McDonald.  
Captain Wilson.  
Colonel Ormsby.  
Colonel Simmons.  
General Taylor.

Major Young.  
Captain Singer.  
Mr. Rendel.

Page 44, paragraph 1, Draft; now page lxxxi., paragraph 7, Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following be added to this paragraph:—"They would however add, that they are of opinion that in the manufacture of steel guns more care is required in the selection of the material and in the tests of the various pieces composing the gun than is required in the manufacture of a gun of coiled iron; also that an error with the former will be more fatal than with the latter."

Amendment.—Proposed by *Captain Wilson*, seconded by *Colonel Ormsby*, "The Committee, however, add that the failure of a gun composed entirely of steel would be attended with more serious consequences than if constructed with a steel barrel and super-imposed coils."

The Committee divided.

|                                                                                                                                           |                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| <p><i>For.</i></p> <p>Captain Wilson.<br/>Colonel Ormsby.<br/>Colonel Simmons.<br/>Major Young.<br/>Mr. McDonald.<br/>General Taylor.</p> | <p><i>Against.</i></p> <p>Captain Singer.<br/>Mr. Rendel.</p> |
|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|

Page 44, line 13, Draft; now page lxxxi, line 52, Report.

Proposed by *Major Young*, seconded by *Captain Singer*, That the word "eventually" be inserted.

The Committee divided.

|                                                                                                                     |                                                                                     |
|---------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <p><i>For.</i></p> <p>Major Young.<br/>Captain Singer.<br/>Mr. Rendel.<br/>Colonel Ormsby.<br/>Colonel Simmons.</p> | <p><i>Against.</i></p> <p>Captain Wilson.<br/>General Taylor.<br/>Mr. McDonald.</p> |
|---------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|

Page 44, line 56, Draft; now page lxxxii, line 16, Report.

Proposed by *General Taylor*, seconded by *Captain Wilson*, That the words "at any rate" be omitted.

Amendment.—Proposed by *Captain Singer*, seconded by *Major Young*, That the remainder of the sentence from those words inclusive be omitted.

The Committee divided.

|                                                                                                                       |                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| <p><i>For.</i></p> <p>Captain Singer.<br/>Major Young.<br/>Colonel Ormsby.<br/>Colonel Simmons.<br/>Mr. McDonald.</p> | <p><i>Against.</i></p> <p>Mr. Rendel.<br/>Captain Wilson.<br/>General Taylor.</p> |
|-----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|

109, Victoria Street, Westminster, July 21, 1865.

MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President.*

|                             |                                     |
|-----------------------------|-------------------------------------|
| MAJOR-GENERAL TAYLOR, R.A.  | CAPTAIN SINGER, R.N.                |
| COLONEL ORMSBY, R.A.        | MAJOR YOUNG, R.A.                   |
| CAPTAIN WILSON, R.N.        | MR. STUART RENDEL.                  |
| COLONEL SIMMONS, R.E., C.B. | MR. McDONALD.                       |
|                             | MAJOR DYER, R.A., <i>Secretary.</i> |

Page 45, line 20, Draft; now page lxxxii., after paragraph 6, Report.

Proposed by *Mr. McDonald*, not seconded, That the following be inserted:—"This rear vent stood 2,212 rounds, and though at first liable to foul from the hole being too small, yet having been rimmed out from .125 of an inch to .175 of an inch, it was thereafter used without any difficulty.

"By means of the quick-match in the cartridge, pricking is not required, the vent being drifted while the gun is run home. The rear vent is more accessible for stopping than the top vent, and in a mechanical point of view Mr. Whitworth claims for it three great advantages:—

"1st. In not wounding the barrel, which is the expensive part of the gun.

"2nd. In not disturbing the balance of the gun from the rush of gas up the top vent during the explosion of the charge.

"3rd. That a vent so placed can, by the use of platinum, be made as durable as the gun itself, and can be readily withdrawn and a new one substituted, if requisite.

"Though the tube in the cartridge is a complication, it is not indispensable, except where maximum ranges are required, and the superior range of the gun gives it a margin to play with in this respect."

Proposed by *Mr. Rendel*, seconded by *Mr. McDonald*, That the words "not by any means" be omitted.

The Committee divided.

|                                                                                                                     |                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| <p><i>For.</i></p> <p>Mr. Rendel.<br/>Mr. McDonald.<br/>Captain Wilson.<br/>General Taylor.<br/>General Rumley.</p> | <p><i>Against.</i></p> <p>Colonel Ormsby.<br/>Colonel Simmons.<br/>Major Young.<br/>Captain Singer.</p> |
|---------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|



Page 46, line 6, Draft ; now page lxxxiii., line 11, Report.

Proposed by *Mr. McDonald*, not seconded, That the following be substituted for the remainder of the paragraph :—" having a possible bearing on their opinion that the rear vent is objectionable."

Page 46, line 51, Draft ; now page lxxxiii., after paragraph 7, Report.

Proposed by *Mr. Rendel*, seconded by *General Taylor*, That the following be added :—" but this price will no doubt be reduced in course of manufacture."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Ormsby.  |
| General Taylor. | Colonel Simmons. |
| Major Young.    | Captain Singer.  |
|                 | Captain Wilson.  |

*Mr. McDonald* left the Committee.

Page 47, line 40, Draft ; now page lxxxiv., line 5, Report.

Proposed by *Mr. Rendel*, seconded by *General Taylor*, That the following be inserted :—" At the same time the Committee are fully aware that the cost of the production of wrought-iron coiled hoops has been and is being greatly reduced, and they are unable, therefore, to state that there is any immediate prospect of an alteration in the present relative cost of steel and wrought-iron hoops."

Amendment.—Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, "This reduction in the price of steel will, however, probably be simultaneous with a considerable reduction in that of coiled wrought iron."

Carried *Nem. con.*

Page 48, line 4, Draft ; now page lxxxiv., line 27, Report.

Proposed by *Mr. Rendel*, seconded by *Captain Wilson*, That the words "These prices" be substituted for the words "Mr. Whitworth adds that his."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Captain Wilson. | Colonel Ormsby.  |
| Major Young.    | Colonel Simmons. |
| Captain Singer. |                  |
| General Taylor. |                  |

Page 49, lines 32 to 39, Draft ; now page lxxxv., lines 23 to 27, Report.

Proposed by *Mr. Rendel*, seconded by *Major Young*, That the following be substituted for the above lines :—" After considering the subject, and witnessing the process of adapting the Whitworth and muzzle-loading Armstrong projectiles to their respective systems of rifling, the Committee are unable to state that there is any great difference in their total cost."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Ormsby.  |
| Major Young.    | Colonel Simmons. |
| General Taylor. | Captain Singer.  |
|                 | Captain Wilson.  |
|                 | Mr. McDonald.    |

Page 49, paragraph 5, Draft ; now page lxxxv., paragraph 5, Report.

Proposed by *Major Young*, seconded by *Mr. Rendel*, That this paragraph be omitted.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Major Young.    | Colonel Ormsby.  |
| Mr. Rendel.     | Colonel Simmons. |
| General Taylor. | Captain Singer.  |
|                 | Captain Wilson.  |
|                 | Mr. McDonald.    |

*Royal Arsenal, Woolwich, July 22, 1865.*

MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President.*

|                             |                                     |
|-----------------------------|-------------------------------------|
| MAJOR-GENERAL TAYLOR, R.A.  | CAPTAIN SINGER, R.N.                |
| COLONEL ORMSBY, R.A.        | MAJOR YOUNG, R.A.                   |
| CAPTAIN WILSON, R.N.        | MR. McDONALD.                       |
| COLONEL SIMMONS, R.E., C.B. | MR. STUART RENDEL                   |
|                             | MAJOR DYER, R.A., <i>Secretary.</i> |

Page 48, after 1st Table, Draft ; now page lxxxiv., after 1st Table, Report.

Proposed by *Mr. McDonald*, seconded by *Captain Wilson*, That the following be inserted :—" It

will be recollected, however, that the differences in the calibres and weights of the Armstrong and Whitworth guns do not admit of a strict comparison in price."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. McDonald.   | Colonel Simmons. |
| Captain Wilson. | Mr. Rendel.      |
|                 | Colonel Ormsby.  |
|                 | Major Young.     |
|                 | Captain Singer.  |
|                 | General Taylor.  |

Page 51, lines 37 to 40, Draft ; now page lxxxvi., after line 10, Report.  
Proposed by *Mr. Rendel*, That these lines be omitted.

Carried *Nem. con.*

109, Victoria Street, Westminster, July 31, 1865.

MEMBERS PRESENT :

MAJOR GENERAL RUMLEY, *President.*

MAJOR-GENERAL TAYLOR, R.A.  
CAPTAIN WILSON, R.N.  
COLONEL SIMMONS, R.E., C.B.  
CAPTAIN SINGER, R.N.

MAJOR YOUNG, R.A.  
MR. STUART RENDEL.  
MR. McDONALD.

MAJOR DYER, R.A., *Secretary.*

It having been brought to the notice of the Committee that the remark at page lxiv. of the Report, in reference to the practice with the muzzle-loading Armstrong gun, is at variance with the practice recorded at page lxxxii. of the Report with the top vent from the Whitworth gun,

Proposed by *Mr. Rendel*, seconded by *Colonel Simmons*, last paragraph, page lxiv., That for the words "but is the most remarkable in point of accuracy that the Committee have recorded throughout the course of their experiments," the following be substituted :—"is very remarkable in point of accuracy."

Carried *Nem. con.*

Page 1, paragraph 1, lithograph Draft.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That the latter portion of this paragraph from the word "took" be omitted.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Simmons. |
| Captain Singer. | Mr. McDonald.    |
| Major Young.    | Captain Wilson.  |
| General Taylor. |                  |

Page 2, paragraph numbered 1, lithograph Draft ; now page lxxxvii., paragraph 1, Report.

Proposed by *Mr. McDonald*, not seconded, That after the words "accuracy of fire," the following be substituted for the last portion of this paragraph :—"when the question of pitch is included, the three methods of rifling are not on an equality, for the polygonal system of rifling is obviously better adapted to a sharp pitch should such prove desirable, than projectiles with soft metal coating or studs, especially in guns of large calibres requiring proportionate charges."

Page 2, paragraph numbered 2, lithograph Draft ; now page lxxxvii., paragraph 2, Report.

Proposed by *Major Young*, seconded by *General Taylor*, That for the words "system do not act injuriously on the bores of steel barrels," the following be substituted :—"of the three systems have not been found, in the experiments carried on by the Committee, to act injuriously on the steel barrels, but there is undoubtedly less chance of injury or wear by the use of a soft metal on the bearing surface of the projectile."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Major Young.    | Colonel Simmons. |
| General Taylor. | Captain Singer.  |
|                 | Captain Wilson.  |

*Mr. Rendel* not voting in *Mr. McDonald's* absence.

Same paragraph.

Proposed by *Mr. Rendel*, seconded by *Major Young*, That the following words be added :—"up to the calibres tested by the Committee."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Major Young.    | Colonel Simmons. |
| General Taylor. | Captain Singer.  |
|                 | Captain Wilson.  |



Page 2, paragraph numbered 3, lithograph Draft ; now page lxxxvii., paragraph 3, Report.  
Proposed by *Major Young*, seconded by *Mr. Rendel*, That the following be substituted :—" That it is not imperative but desirable in artillery to use a soft metal on the projectiles to protect the bores of rifled guns."

Amendment.—Proposed by *Captain Singer*, seconded by *General Taylor*, That this paragraph be omitted.

The Committee divided.

*For.*  
*Captain Singer.*  
*General Taylor.*  
*Major Young.*

*Against.*  
*Colonel Simmons.*  
*Captain Wilson.*

*Mr. Rendel* not voting in *Mr. McDonald's* absence.

Page 2, paragraph numbered 4, lithograph Draft ; now page lxxxvii., paragraph 4, Report.  
Proposed by *Major Young*, seconded by *Mr. Rendel*, That the last portion of this paragraph be omitted.

The Committee divided.

*For.*  
*Major Young.*

*Against.*  
*Colonel Simmons.*  
*Captain Singer.*  
*Captain Wilson.*  
*General Taylor.*

Page 2, lithograph Draft ; now page lxxxvii., Report.

That the following be inserted as paragraph 5 :—" That the systems of lead coating and of soft metal studs as applied by Sir W. Armstrong empowers the use of the cylindrical or most capacious form of projectile, which in guns of large calibre is of great importance. It also provides the projectile with a certain power of self-adjustment."

Carried *Nem. con.*

Page 3, paragraph numbered 8, lithograph Draft ; now page lxxxvii., paragraph 8, Report.  
Proposed by *Major Young*, seconded by *Mr. Rendel*, That the word "abundant" be omitted from this paragraph.

The Committee divided.

*For.*  
*Major Young.*  
*Mr. Rendel.*

*Against.*  
*Colonel Simmons.*  
*Captain Singer.*  
*Captain Wilson.*  
*General Taylor.*

Page 3, paragraph numbered 10, lithograph Draft ; now page lxxxvii., paragraph 10, Report.  
Proposed by *Mr. Rendel*, seconded by *General Taylor*, That the word "somewhat" be inserted.

The Committee divided.

*For.*  
*General Taylor.*  
*Major Young.*

*Against.*  
*Colonel Simmons.*  
*Captain Singer.*  
*Captain Wilson.*

Page 3, paragraph numbered 11, lithograph Draft.  
Proposed by *Captain Singer*, seconded by *Major Young*, That this paragraph be omitted.

The Committee divided.

*For.*  
*Captain Singer.*  
*Major Young.*  
*Colonel Simmons.*

*Against.*  
*Captain Wilson.*  
*General Taylor.*

Page 3, lithograph Draft ; now page lxxxvii., Report.

Proposed by *Captain Singer*, seconded by *Colonel Simmons*, That the following be paragraph No. 11 :—" That the wedge system of closing the breech adopted by Sir W. Armstrong with his 70-pounder, and recommended by him for all heavier breech-loaders, has proved itself very highly effective ; although for various reasons already stated in the body of this Report, the Committee consider that muzzle-loading guns are better adapted for the general requirements of the service."

Carried *Nem. con.*

Amendment.—Proposed by *Mr. Rendel*, seconded by *Major Young*, That for the words "wedge system of closing the breech" in the above paragraph, the following be substituted :—" system of breech-loading."

The Committee divided.

*For.*  
*Major Young.*  
*General Taylor.*

*Against.*  
*Colonel Simmons.*  
*Captain Singer.*  
*Captain Wilson.*

109, Victoria Street, Westminster, August 1, 1865.

## MEMBERS PRESENT:

MAJOR-GENERAL RUMLEY, *President*.

MAJOR-GENERAL TAYLOR, R.A.  
 COLONEL ORMSBY, R.A.  
 CAPTAIN WILSON, R.N.  
 COLONEL SIMMONS, R.E., C.B.

CAPTAIN SINGER, R.N.  
 MAJOR YOUNG, R.A.  
 MR. McDONALD.  
 MR. STUART RENDEL.  
 MAJOR DYER, R.A., *Secretary*.

On confirming the Minutes of 31st July.

Proposed by *Mr. McDonald*, not seconded, The following for paragraph No. 11, lithograph Draft:—"The Committee desire to point out that whereas the Armstrong 70-pr. has a larger calibre by  $1\frac{1}{4}$  inches than the Whitworth, and a proved capacity for a powder charge 40 per cent. greater than its own service charge, the Whitworth 70-pr. using the same service charge of 10 lbs., is a heavier gun. The use of a service charge for endurance 40 per cent. under what the calibre of the Armstrong muzzle-loading 70-pr. enables it to consume effectively must be assumed as an admission that it could not stand against the Whitworth 70-pr. for endurance with the charges due to its larger calibre. It follows, therefore, that the conditions of safety enabling guns as light as Sir W. Armstrong's 70-pr. guns to be constructed have been purchased by a serious reduction in the amount of powder charge due to that calibre. Had the Armstrong 70-pr. guns used full charges like the Whitworth for endurance the Armstrong muzzle-loader would have consumed 12,000 lbs. of additional powder, and the Armstrong breech-loader 15,000 lbs."

Paragraph No. 12, lithograph Draft; now page lxxxvii., Report.

Proposed by *Mr. Rendel*, seconded by *General Taylor*, That the following be inserted:—"have shown a possibility of injury to the gun."

The Committee divided.

*For.*  
 Mr. Rendel.  
 General Taylor.  
 Major Young.

*Against.*  
 Colonel Ormsby.  
 Colonel Simmons.  
 Captain Singer.  
 Captain Wilson.  
 Mr. McDonald.

Paragraph No. 13, lithograph Draft; now page lxxxvii., Report.

Proposed by *Captain Singer*, seconded by *Colonel Ormsby*, That this paragraph end at the word "ditches."

Carried *Nem. con.*

Same paragraph.

Proposed by *General Taylor*, not seconded, That the following be added:—"For siege purposes it has also the advantage of calling for less draught, and being lighter to move and mount in the trenches."

Amendment.—Proposed by *Mr. Rendel*, seconded by *Major Young*, That after the word "positions" the following be added:—"where breech-loading presents special advantages."

The Committee divided.

*For.*  
 Mr. Rendel.  
 Major Young.

*Against.*  
 Colonel Ormsby.  
 Colonel Simmons.  
 Captain Singer.  
 Captain Wilson.  
 General Taylor.  
 Mr. McDonald.

Amendment.—Proposed by *General Taylor*, seconded by *Captain Wilson*, That the word "certain" be inserted before the word "positions," and that the latter finish the sentence.

The Committee divided.

*For.*  
 General Taylor.  
 Captain Wilson.  
 Colonel Ormsby.  
 Major Young.

*Against.*  
 Colonel Simmons.  
 Captain Singer.  
 Mr. McDonald.

Amendment.—Proposed by *Colonel Simmons*, seconded by *Captain Singer*, That the following words be added:—"such as casemates for flanking ditches, &c."

The Committee divided.

*For.*  
 Colonel Simmons.  
 Captain Singer.  
 Colonel Ormsby.  
 Mr. McDonald.  
 General Rumley.

*Against.*  
 Major Young.  
 Mr. Rendel.  
 Captain Wilson.  
 General Taylor.



Same paragraph.

Proposed by *General Taylor*, seconded by *Major Young*, That the following be added :—“ The capability it possesses of being in special cases rapidly fired with the recoil checked, makes it a valuable gun for siege purposes.”

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| General Taylor. | Colonel Ormsby.  |
| Major Young.    | Colonel Simmons. |
| Mr. Rendel.     | Captain Singer.  |
|                 | Captain Wilson.  |
|                 | Mr. McDonald.    |

Paragraph No. 18, lithograph Draft ; now page lxxxviii., Report.

Proposed by *Mr. Rendel*, seconded by *Captain Singer*, That the following be added to this paragraph :—“ Within these limits, however, the muzzle-loading Armstrong exhibited a considerable superiority to the Whitworth in ease of loading under these conditions.”

Carried *Nem. con.*

Paragraph No. 20, lithograph Draft ; now page lxxxviii., Report.

Proposed by , not seconded, The following as this paragraph :—“ The Whitworth guns, the calibre of which is duly proportioned to their service charge, so as to secure the maximum results in range and penetration for that particular calibre in ordinary practice, have an advantage in penetration at moderate ranges over guns of larger calibre, enabling them to consume larger charges than they are adapted to use on service, where the quality of endurance is required.”

Paragraph No. 20, lithograph Draft ; now page lxxxviii., Report.

Proposed by *Major Young*, seconded by *Captain Singer*, That the word “moderately” be omitted.

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Major Young.    | Colonel Ormsby.  |
| Captain Singer. | Colonel Simmons. |
| Mr. Rendel.     | Mr. McDonald.    |
| Captain Wilson. |                  |
| General Taylor. |                  |

Same paragraph.

Proposed by *Colonel Simmons*, seconded by *Captain Singer*, That the following be added :—“ By long ranges the Committee do not understand extreme ranges, but ranges at which ships might engage each other, viz., from 1,000 to 1,500 yards.”

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Simmons. | Major Young.    |
| Captain Singer.  | Mr. Rendel.     |
| Colonel Ormsby.  |                 |
| Captain Wilson.  |                 |
| General Taylor.  |                 |
| Mr. McDonald.    |                 |

Paragraph No. 21, lithograph Draft ; now page lxxxviii., Report.

Proposed by *Mr. McDonald*, not seconded, That the following be added :—“ But the Committee assume that this penetration is purchased at a certain sacrifice of accuracy rendering it necessary to substitute hollow-headed for solid shot.”

Same paragraph.

Proposed by *Major Young*, seconded by *Captain Singer*, That the following be added :—“ and destructive effect at comparatively short ranges.”

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Major Young.    | Colonel Ormsby.  |
| Captain Singer. | Colonel Simmons. |
| Mr. Rendel.     | Mr. McDonald.    |
| Captain Wilson. |                  |
| General Taylor. |                  |

Paragraph No. 20, lithograph Draft ; now page lxxxviii., Report.

Proposed by *Colonel Simmons*, seconded by *Mr. McDonald*, That the following be added :—“ and destructive effect ” after “ penetration.”

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Simmons. | Major Young.    |
| Mr. McDonald.    | Captain Singer. |
| Colonel Ormsby.  | Mr. Rendel.     |
|                  | Captain Wilson. |
|                  | General Taylor. |

Paragraph No. 23, lithograph Draft; now page lxxxviii., Report.

Proposed by *Captain Singer*, seconded by *Major Young*, That the following be substituted for lines 2, 3, 4, 5, 6, 7, 8, of the paragraph in Draft:—"And it appears that both the accuracy and range of the muzzle-loading Armstrong gun are greatly increased when the maximum charge".

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Captain Singer. | Colonel Ormsby.  |
| Major Young.    | Colonel Simmons. |
| Mr. Rendel.     | Mr. McDonald.    |
| Captain Wilson. |                  |
| General Taylor. |                  |

Proposed by *Colonel Simmons*, seconded by *General Taylor*, That the words "14 lbs. charge" be substituted for "maximum" in *Captain Singer's* motion.

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Simmons. | Major Young.    |
| General Taylor.  | Captain Singer. |
| Colonel Ormsby.  | Mr. Rendel.     |
| Mr. McDonald.    |                 |
| Captain Wilson.  |                 |

Proposed by *Colonel Simmons*, seconded by *Colonel Ormsby*, "The Committee have to observe that this conclusion is arrived at from a limited practice, viz., 27 rounds."

The Committee divided.

| <i>For.</i>      | <i>Against.</i> |
|------------------|-----------------|
| Colonel Simmons. | Major Young.    |
| Colonel Ormsby.  | Captain Singer. |
| General Taylor.  | Mr. Rendel.     |
| Mr. McDonald.    | Captain Wilson. |
| General Rumley.  |                 |

Paragraph 26, lithograph Draft; now page lxxxviii., Report.

Proposed by *Mr. McDonald*, seconded by *Colonel Ormsby*, That the following be added:—"The construction of the former is less favourable to their getting so lodged."

Carried *Nem. con.*

Proposed by *Mr. Rendel*, seconded by *Major Young*, That the paragraph run as follows:—"The construction of the former is less favourable for penetration."

| <i>For.</i>  | <i>Against.</i>  |
|--------------|------------------|
| Mr. Rendel.  | Colonel Ormsby.  |
| Major Young. | Colonel Simmons. |
|              | Captain Singer.  |
|              | Captain Wilson.  |
|              | General Taylor.  |

Paragraph No. 30, lithograph Draft; now page lxxxix., Report.

Proposed by *General Taylor*, seconded by *Captain Wilson*, That the following be added:—"For the 70-pounders."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| General Taylor. | Colonel Ormsby.  |
| Captain Wilson. | Colonel Simmons. |
| Mr. Rendel.     | Major Young.     |
|                 | Captain Singer.  |
|                 | Mr. McDonald.    |

Paragraph 31, lithograph Draft; now page lxxxix., Report.

Proposed by *Mr. Rendel*, seconded by *Major Young*, That this paragraph finish at the word "transport."

The Committee divided.

| <i>For.</i>     | <i>Against.</i>  |
|-----------------|------------------|
| Mr. Rendel.     | Colonel Ormsby.  |
| Major Young.    | Colonel Simmons. |
| Captain Wilson. | Captain Singer.  |
| General Taylor. |                  |
| Mr. McDonald.   |                  |



109, Victoria Street, Westminster, August 3, 1865.

MEMBERS PRESENT :

MAJOR-GENERAL RUMLEY, *President.*

MAJOR-GENERAL TAYLOR, R.A.  
COLONEL ORMSBY, R.A.  
CAPTAIN WILSON, R.N.  
COLONEL SIMMONS, R.E., C.B.

CAPTAIN SINGER, R.N.  
MAJOR YOUNG, R.A.  
MR. STUART RENDEL.  
MR. McDONALD.  
MAJOR DYER, R.A., *Secretary.*

Page lxxxix., paragraph No. 31.

*Captain Wilson* recorded his dissent from the opinion expressed in this paragraph.

Paragraph No. 24.

Proposed by *Mr. McDonald*, seconded by *General Taylor*, That the following be added :—" They regret that they were neither able to test the endurance of the muzzle-loading Armstrong gun with charges of 14 lbs. nor Mr. Whitworth's guns with the top vent."

The Committee divided.

*For.*

Mr. McDonald.  
General Taylor.  
Colonel Ormsby.

*Against.*

Colonel Simmons.  
Major Young.  
Captain Singer.  
Mr. Rendel.  
Captain Wilson.

The Committee signed the Report and adjourned *sine die*.





# R E P O R T

OF



## THE SPECIAL ARMSTRONG AND WHITWORTH COMMITTEE.

---

VOL. II.

---

### MINUTES OF EVIDENCE, APPENDIX, AND INDEX.

---

Presented to both Houses of Parliament by Command of Her Majesty.

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LONDON:

PRINTED BY GEORGE EDWARD EYRE AND WILLIAM SPOTTISWOODE,  
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.

FOR HER MAJESTY'S STATIONERY OFFICE.

1866.





# MINUTES OF EVIDENCE

TAKEN BEFORE

## THE ARMSTRONG AND WHITWORTH COMMITTEE AT THE WAR OFFICE.

Tuesday, 6th January 1863.

PRESENT :

PRESIDENT :—MAJOR-GENERAL RANDAL RUMLEY, Inspector-General of Infantry.

COLONEL ORMSBY, R.A.

COLONEL TAYLOR, R.A., Commandant School of  
Gunnery.

COLONEL SIMMONS, C.B., R.E.

CAPTAIN PREEDY, R.N.

CAPTAIN SINGER, R.N.

MAJOR YOUNG, Director of Artillery Studies.

SECRETARY :—CAPTAIN DYER, R.A., Assistant Inspector of Artillery.

MAJOR-GENERAL RANDAL RUMLEY IN THE CHAIR.

JOSEPH WHITWORTH, Esq., examined.

J. Whitworth,  
Esq.

6 Jan. 1863.

1. (*Chairman.*) The Committee are appointed to examine and report upon certain facts relative to the details contained in a confidential communication which is before them, and they will be very much obliged to you, if you will take those details in their order, and inform the Committee what your views upon them are?—With reference to the field guns, the Manchester Ordnance and Rifle Company which I have established are now making 1, 3, 6, and 12-pounder field guns. The weight of the 12-pounder field gun is about 10 cwt., and its carriage about 10 cwt., which is the weight that I would prefer. Instead of the 12-pounder, I should strongly recommend that a gun not larger than a 9-pounder gun should be used, on account of having it so much lighter. The reasons do not exist now for a heavy field gun, which used to exist formerly, for we obtain a low trajectory with a comparatively light gun. I may mention, going to an extreme case, that we are now making 1-pounder guns, which gun only weighs with its carriage  $4\frac{1}{2}$  cwt., and it carries with only its limber and its carriage 200 rounds of ammunition into the field. The range of this gun at  $5^\circ$  is 2,300 yards, being 300 yards more than that of the service 12-pounder gun. Now a battery of those guns taking as many rounds of ammunition into the field as a 12-pounder gun would be worked by about 20 horses; whereas I think the number of horses required for a battery of 12-pounder guns is 192. Not that I would propose this gun as a substitute for a heavier field gun, but I mention it as a gun that might on many occasions take the place of the rifle.

2. What did you say the weight of the gun was?—The gun is 1 cwt., and the carriage and the gun together weigh  $4\frac{1}{2}$  cwt.

3. (*Capt. Singer.*) What is the calibre?—The calibre is 1·3 inch.

4. (*Col. Simmons.*) Do you reckon the calibre by the inscribing circle or the circumscribing circle?—By the circumscribing circle; the largest diameter. The range of the 1-pounder, as I stated, at  $5^\circ$  is 2,300 yards; and at  $1^\circ 40'$  it is 1,000 yards. Now, the angle of elevation of a Whitworth rifle at 1,000 yards is  $3^\circ$ , and that of the Enfield is much more; so that in the case of this small gun you have a trajectory of  $1^\circ 40'$  against  $3^\circ$  in the rifle, so that wherever this little gun could be substituted for the rifle, it must be an immense advantage. The height of its trajectory at 700 yards would not much exceed that of a man on horseback.

5. (*Col. Taylor.*) What is the length of the gun?—It is 33 bores. What I have just now said with respect to the 1-pounder gun is merely in support of my opinion with reference to a lighter field gun, something less than a 12-pounder.

6. (*Col. Ormsby.*) What would be the difference of range between the 9-pounder gun which you propose and the 12-pounder?—Very little indeed. With my 12-pounder gun we obtained at an elevation of  $33^\circ$  a range of 10,260 yards.

7. What is the difference of calibre between the 9-pounder and the 12-pounder?—The 9-pounder is 2·7 inches, and the 12-pounder is 3 inches.

8. (*Col. Taylor.*) I find in an extract from the summary of your experiments at Southport which you furnished to the Ordnance Select Committee that at  $35^\circ$  the mean of two shots with the 3-pounder is 9,297·5; is that the gun you mean?—No, that was with a 3-pounder gun.

9. (*Col. Ormsby.*) What is the difference of length between the 9-pounder and the 12-pounder?—They would both be 26 bores in length.

10. (*Col. Simmons.*) Could you give the Committee for each gun the weight, calibre, length, weight of carriage, and any particulars which you have as to the range for each field gun in succession?—We have a 6 and a 12-pounder; we have not a 9-pounder; we can furnish the particulars as to the 6 and 12-pounder.

11. You have been speaking of the 9-pounder; has no 9-pounder been made?—No, we have not made a 9-pounder; we have 6-pounders and 12-pounders.

12. Then what you state with regard to the 9-pounder is merely theoretical?—Yes.

13. (*Col. Ormsby.*) Those are muzzle-loaders, are they not?—Yes; they are muzzle-loaders, but we have both 12 and 6-pounder breech-loaders. The longest range that we have got with the 12-pounder at  $5^\circ$  is 2,600 yards, and with the 1-pounder 2,300 yards; at short ranges there is not that difference. I know that the French and other continental nations are very much in favour of light guns.

14. (*Col. Simmons.*) Could you give us the weight, calibre, and length of the 6-pounder?—I have not all the particulars now, but I will be happy to furnish them.

15. (*Col. Ormsby.*) What is the charge of the 9-pounder?—The charge would be one-sixth the weight of the shot.

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16. (*Col. Taylor.*) You take one-sixth as the regular rule, do you not?—Yes; one-sixth the weight of the shot, three diameters in length. The weights of the shot that we give are always three diameters long unless expressed to the contrary; but in the case of shells, where we want them to hold a large charge, we make them four or more diameters long.

17. (*Capt. Singer.*) What is the difference in weight between a brass 12-pounder and one of homogeneous metal?—The old brass 9-pounder block weighed about 14½ cwt., and we rifled two of them and made them 12-pounders. Two others that we sent to Shornecliff we reduced 3 cwt., leaving them something more than 11 cwt., and I think that we may make a brass gun for a 12-pounder 10 cwt.; and taking into account the recoil, as far as my experience goes, I consider that a 12-pounder should not be much lighter than that.

18. (*Col. Ormsby.*) I presume that 10 cwt. is light enough for field battery work?—Yes.

19. (*Col. Taylor.*) Are the Committee to understand that those guns which you have mentioned now represent what you propose for field artillery?—Yes.

20. Have you any other gun which you wish to suggest to the Committee or bring forward as a field gun?—We have a 3-pounder besides the 1-pounder, the 6-pounder, and the 12-pounder.

21. If you think of submitting for the acceptance of Government certain guns, will you state clearly what they all are?—I do not think I am competent to do that; I merely tell you what guns we have, and I think it is for the Committee to decide what guns they will try.

22. If you look at the heading of the paper which is before you on the table, you will see that “the Committee are appointed to examine and report upon certain facts which require to be carefully ascertained” before any satisfactory opinion can be pronounced “upon the different descriptions of guns and of ammunition proposed by Sir William Armstrong and by Mr. Whitworth.” Therefore this implies that there are certain guns and ammunition which you are prepared to place before the Committee at your proposal?—It is so, and I shall be very glad if the Committee will say what they would advise in the matter. It would be too much to propose four descriptions of field guns. There are the 1-pounder, the 3-pounder the 6-pounder, and the 12-pounder.

23. (*Col. Ormsby.*) And the 9-pounder?—That would be instead of the 12-pounder, if it were deemed desirable to have a lighter gun; if you did not like to go to the 6-pounder, it would be then open to you to go to the 9-pounder. There are the 1-pounder, the 3-pounder, the 6-pounder, the 9-pounder and the 12-pounder; there would be five different descriptions of guns, and I could not think of proposing five different guns for the field service.

24. (*Capt. Singer.*) Why should not you propose four or five and allow the Committee to decide?—Yes, I might do that.

25. (*Col. Ormsby.*) Is there any reason why you should not propose six descriptions of guns, because we have always had six descriptions of field guns in the service; we have had the 1-pounder, the 3-pounder, the 6-pounder, the 9-pounder, and the 12-pounder, formerly smooth-bores?—Then you would want a howitzer for shells.

26. (*Col. Taylor.*) Are the Committee to understand clearly that you contemplate a separate gun as a shell gun?—Yes, a howitzer, if light field guns, such as 6-pounders, are employed. I would add that my 12-pounders fire both shot and shell, as in fact do the smaller guns, but their shells are of small capacity.

27. And do you in connexion with that shell gun contemplate an alteration of calibre, an alteration, in fact, of the character which you have already enunciated, that is to say, making the projectile three calibres in length?—Four calibres in length for shell, and three for shot.

28. That would be in guns of the same calibre. Would you give the increased internal dimensions

which you require for the shell by elongation of the projectile, or by increased calibre?—In firing from the same gun solid shot and shell, I would fire the solid shot three diameters in length, and the shell four or more diameters.

29. You have just stated, have you not, that you contemplate a separate gun for firing shell?—Yes; it has been deemed desirable to have a gun larger in the bore, specially for Shrapnell shell.

30. Taking, for instance, the 12-pounder as a field gun, to which you wish to add a shell gun, what calibre would you give to the shell gun to accompany it?—I have not got that worked out.

31. But you would contemplate for the shell gun increasing your calibre and not elongating the projectile?—Yes.

32. (*Col. Ormsby.*) The weight of the gun would be the same, would it not?—Yes.

33. Only it would be a larger bore?—Yes; it would be a larger bore for shorter ranges.

34. (*Col. Simmons.*) In fact it would bring back the artillery to the old organization of guns and howitzers, having two different calibres in each battery according as you require to fire solid shot or shell?—Yes; but I must submit that that is a question entirely for the Committee, I do not presume to know at all what is the best for the service. I may mention that in all my guns, I contemplate firing very long projectiles when there is occasion for them—much longer than anything which has been thought of before. I have found no difficulty whatever in firing shell 10 diameters long.

35. (*Col. Taylor.*) You do that by diminishing the charge, I presume?—Yes; by diminishing the charge you may fire a very long shell indeed by giving plenty of rotary motion; it is a question of rotary motion.

36. But you could not give greater rotary motion, could you, without increasing the rapidity of the twist?—No.

37. Therefore the same gun could not give to a longer projectile a greater rotary motion than it gives to a shorter one?—No; but in my guns I have double the rotary motion of any other gun.

38. (*Col. Simmons.*) What is your rule as regards the rapidity of twist, is it so many calibres, or have you any expression by which to designate it?—It is double that of the rifle. In my rifle, as you are aware, it is one turn in 20 inches, whereas in the Enfield it is one turn in 78 inches.

39. (*Col. Taylor.*) In your twist your scale is one of inches, not of calibres, is it not?—Yes; I have the pitch of the rifling, and I can give you that with regard to any of them. In the 12-pounder it is one turn in 55 inches, and in the 1-pounder it is one turn in 20 inches. When you have an iron projectile, you must give a much more rapid turn than in the case of lead, on account of the specific gravity being so much less.

40. (*Col. Simmons.*) Is your 1-pounder a leaden shot?—No; an iron shot.

41. (*Col. Taylor.*) Do you not think that it is a better way to designate the twist by calibres than by inches, because you always have to calculate what the comparison of the inch to the calibre is?—Yes, I dare say it is.

42. All those experimental guns give their twist in feet, one turn in 25 feet, one turn in 64 feet, and so on?—I should like to know what is the twist of the Armstrong 12-pounder?

43. One turn in 37 calibres?—That is 111 inches, and ours is 55; that is about double, within an inch.

44. In your brass-muzzled field gun is your twist one turn in 55 inches?—Yes.

45. (*Col. Ormsby.*) Do you intend to fire shells from the 9-pounder and the 6-pounder field gun?—Yes.

46. Would you make a shell to fire out of the same gun as the solid shot?—Yes; but it would be larger for Shrapnell. I fire common shells out of the same gun.



47. (*Capt. Singer.*) You would fire small shell from small guns, and Shrapnells from howitzers?—Yes.

48. (*Col. Ormsby.*) Were those Shrapnell shells, or common shells that you fired at Shoeburyness?—They were Shrapnells.

49. (*Col. Taylor.*) Were the fuses of those shells ignited by the passing of the gas round the shot in the ordinary way?—Yes.

50. They were not indebted to any detonating material?—No; in all our shells we ignite by the flame which passes through the windage; we have windage to our shot, and the flame always passes by and lights the shell, and we think that a great advantage.

51. (*Major Young.*) Do you propose breech-loading at all for any of your field guns?—No.

52. (*Col. Taylor.*) In fact, you repudiate breech-loading, do you not?—I think the other system is better.

53. If you were asked whether you contemplated adapting the breech-loading system to field guns, would you say that you would rather do without it?—Yes; we make them, but we prefer the muzzle-loading system, it being more simple, and equally quick in loading; and I do not see any advantage in the breech-loading system.

54. There is one danger that you escape by it, which is blowing away a man's arm?—Yes; but we think that we shall get over the necessity of having any flannel bag for muzzle-loading. We have made a great many experiments with solidified powder, and they are so satisfactory, that we require no flannel bag. We have tried the solidified powder both with the rifle and with the gun upon Captain Brown's plan, and found it very satisfactory; he mixes a very small quantity of gum arabic with the powder, and presses it, and that plan is very useful in making shells, as we get 50 per cent. more powder in the shell by compressing it.

55. (*Col. Simmons.*) In what way would there be more security in muzzle-loading by the use of solidified powder; is it not so easily ignitable as the other powder?—It would leave no refuse behind it; in consequence of the refuse of the flannel bag being left behind, there is danger.

56. (*Col. Ormsby.*) Do you propose to have in your field guns anything like a traversing bar, as Sir William Armstrong has in his?—We have made them with a traversing bar; but in those guns that we have furnished lately we have not applied it, for from what I can gather from military men, they prefer the simple movement of the trail.

57. (*Col. Taylor.*) Supposing that the Government were to say to you, we want a battery of six guns furnished to represent your system of field artillery, in what form would you furnish that battery; how many shot guns, and how many shell guns? Have you ever given the question that amount of consideration, or would you merely wish to say that you have such and such guns, and that it would rest with the Government to lay out the system, and apply to you for such guns as are required?—Exactly so. I think it would be presumption on my part to decide upon the matter. I have been able to form an opinion with respect to the light and heavy guns for field artillery, from what I have seen on the continent, and from what common sense would tell one. I cannot help thinking that the 1-pounder gun is of great importance. I have been told by some that it is a toy; but then they compare it with the large field gun instead of with the rifle.

58. It would have no smashing or penetrating power for troops under cover; it would merely be available for troops in the open?—Just so; but by applying it as artillery in the open, it would set ammunition waggons on fire.

59. How would you contemplate doing that?—By firing shell from it. They are firing shell now from the rifle, and the shot of the 1-pounder is 16 times the weight of the rifle. But what is of more im-

portance to my mind than anything else, is its low trajectory, 1 degree 40 minutes against 3 degrees.

60. (*Major Young.*) What gun with ammunition complete have you now ready, which you would wish to submit to the Committee, to compete with any other guns that might be brought before them?—We have not provided any for this experiment.

61. Are you now ready with ammunition so as to make experiments at once, provided the Committee were disposed to enter upon them?—Yes.

62. Of what material are those guns composed that are now ready, namely, the 12-pounder at Shoeburyness, and the 6-pounder at Manchester?—At Shoeburyness there are two guns, a muzzle-loading brass gun, a 12-pounder, and a homogeneous 12-pounder gun, a breech-loader.

63. Of what metal is the 6-pounder at Manchester composed?—That is of homogeneous metal.

64. Is the ammunition ready for us to make the experiments at once?—Yes, at once; any quantity of ammunition, both for the 6-pounder and for the 12-pounder, we have always ready.

65. I think you stated that the 12-pounder is a breech-loader?—The one at Shoeburyness.

66. Have you any 12-pounder muzzle-loader ready?—None finished, but one will be finished in a very short time.

67. (*Col. Taylor.*) What are the Committee to understand you to say is the elevation which you require for your 1-pounder gun?—1° 40' for 1,000 yards; the Enfield rifle is 1° 30' at 500 yards.

68. Would the charge of your 1-pounder be about three ounces?—Yes. We have at Pall Mall 1-pounder guns, 6-pounder guns, and several other things which would interest the Committee if they would like to look in there, and they would understand more of the system in a quarter of an hour than they would otherwise in a day.

69. (*Major Young.*) Is the gun at Shoeburyness that you refer to of precisely the same pattern as the one that you now propose for the field service, with the exception of its being a breech-loader?—It is longer than is desirable for field service.

70. And would it be lighter?—No, it would be quite as heavy.

71. (*Col. Taylor.*) Do not you consider that length is a very important element in the construction of a field gun, on account of the draught over bad ground?—Yes, I believe the gun at Shoeburyness is considered too long for a field gun.

72. (*Col. Ormsby.*) What is the length of that gun?—8 feet 8 in. The length we propose is 78 inches; we like to have the gun as long as possible, because we get a lower trajectory.

73. You propose to have your gun 6 feet 6 in.; do you consider that taking 6 inches off would make much difference in the consumption of powder and in the range?—Yes, it makes a difference. This gun at Shoeburyness, which is 8 feet long, has, I am told, the best trajectory of any gun at Shoeburyness.

74. (*Col. Taylor.*) I find that the range of your 12-pounder at five degrees with a charge of 1.75 lbs. is 2471.4 as the mean, and with 1½ lb., 2376?—Just so.

75. Have you made any improvement in the fuzes which you wish to bring to the attention of the Committee?—No. I take the ordinary fuzes of the service; they are ignited in the same way as the spherical shell, and therefore I have had no occasion to go into that matter.

76. Have you decided on the form of your shell, on the proportions, the dimensions, and the comparative thickness of the shell to the calibre; in fact have you the details of the shells ready to bring forward?—Yes.

77. Is the windage of your projectile the same at the major and minor diameters of the hexagon; have you the same windage on the faces as you have on the angles?—If the Committee will go over with me to Pall Mall I have the various kinds of shot there, and I can explain the principle better than I can

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here. We give the windage on the going-in side, leaving the coming-out side in a perfect state, so that whatever windage we allow we do not interfere with the proper fitting of the shot in coming out.

78. The metal comes out, does it not, with the bearing in contact throughout?—Yes, with its full bearing, and we give the windage all on the going-in side. In fact the bore of the gun is peculiar; it is, strictly speaking, not a hexagon at all, it has 24 surfaces.

79. It is a series of curves, is it not?—Yes, it has 24 different surfaces; we leave in the centre of the flat the original bore, that makes six, then there is the coming-out side, which would give six more, there is the going-in side, which would give six more, and then there is the rounding off of the angles, which would give six more, leaving 24 surfaces. The shot itself is of course extremely simple, and the cheapest form of shot with which I am acquainted. We cast it of the proper form, and we pay to the workmen for the shaping of the shot for the 12-pounder 5*d.* per dozen shot.

80. Is the work so certain by the means you have at command that there would be no chance of any error of form in the shot if you had to supply it in any quantities?—It is. We have fired shots from the casting with good results, and the Committee will see one at Pall Mall just as it was cast. Of course we cannot cast shot with that degree of accuracy with which we can plane them, and there would be slight differences in the range.

81. But the shot are all tooled, are they not, after having been cast?—Yes, as I mentioned just now, we pay the men 5*d.* per dozen shot for tooling them.

82. (*Col. Ormsby.*) There is very little windage in your gun, is there?—We can give any amount of windage you choose without injury. If you give too much you have a waste of powder, but that is all, you do not deteriorate the shooting.

83. How many rounds could you fire from your 12-pounder field gun without the gun getting foul and your being obliged to wash it out?—I do not know. I never saw so extended a trial as the one at Shorncliffe, on which occasion there were 100 rounds fired from each of the four guns, and there was no washing out at all; no lubricating wad was used, only a dry sponge; but I would never fire without a wad unless there was a necessity for it.

84. (*Col. Taylor.*) Can you remember, in the course of your experience, whether you have had many instances of the shot sticking all together?—Never since the first that we made. In the first 68-pounder and 32-pounder cast-iron guns that we rifled we had too tight a fit, we did not allow windage enough.

85. Are you aware that a case of that kind occurred a very short time ago at Shoeburyness?—No; I never knew of such a case.

86. I was obliged to stop the experiment because a shell stuck. I took it out twice, and examined it as carefully as I could without a mirror, but could find nothing to explain it. On trying it again, the shot again stuck in, and I was obliged to report that I could not complete the experiment; but when the artificer came to examine the gun, which was one of those brass 12-pounders, we found an abrasion of the metal of the gun, so slight that I could not believe that it was this which had stopped the shot. The brass of the gun had just been lifted up a little in one place, but it was so trifling that I could hardly believe it to be the cause when the artificer pointed it out to me?—Perhaps you would inform me in what part of the gun it was.

87. It was just so far down that we could see the head of the projectile and get hold of it and turn it, and bring it out again, it was easily repaired?—I never heard of such a case before.

88. (*Col. Ormsby.*) Supposing your guns were knocked over and got full of all sorts of dirt from dragging through a river or a canal or anything of that kind, would there be any danger of the shot

sticking then when the army was on service, and when they had not many means at hand of perfectly cleansing it out?—I consider that you could make any shot stick if you had a quantity of sand and dirt in the gun.

89. Could you clear out the gun sufficiently quickly to prevent that?—Yes.

90. Have you ever tried the experiment of having the bore made very dirty and then seeing what time it would take to clear out that gun for powder and shot?—No.

91. You are aware that in the old smooth-bore gun we had no difficulty, however foul the bore was, in cleansing it and firing it in a couple of minutes?—Just so, but I think it is entirely a question of experiment as to the amount of windage that we ought to allow, and I think it was the opinion of the officers who saw the experiment at Shorncliffe that there was abundant windage, and there the shot were thrown down on the shingle, which I did not approve of, but so it was.

92. (*Major Young.*) Do you consider that the probability of jamming is only the same as exists in the case of the smooth-bore?—It is just the same; my rifled gun is a smooth-bore, in fact, its hexagon sides are smooth.

93. (*Col. Simmons.*) Do you anticipate that you can clean it and get it ready to fire as soon as a smooth-bore?—Yes. In all the trials at Shoeburyness with our breech-loader we never have had any accident.

94. (*Col. Taylor.*) At first you made the communication into the cartridge too small and there were many miss-fires, were there not?—Yes, that was so.

95. And you afterwards invented an instrument, an extractor, to meet the difficulty of withdrawing the cartridges, which answered your purpose?—We always had the extractor.

96. (*Col. Ormsby.*) Did you ever try the greatest number of rounds that you could fire from your gun, say in a quarter of an hour?—The experiment was tried at Shorncliffe, that is the only instance.

97. Was that the quickest firing that you ever saw from your guns?—There was one experiment, I do not know whether it was at Woolwich or at Shoeburyness, but I think it was at Shoeburyness, at which there was a trial against a smooth-bore, when 30 rounds were fired from each description of gun, and the time, I was informed, was the same within a few seconds.

98. (*Col. Taylor.*) That was the case that I alluded to just now when I said that the communication was so small through the cartridge?—But the 30 rounds were fired in the same time as with the smooth-bore.

99. We were firing against Armstrong's 12-pounder on one occasion before you had invented your instrument, and your gun was thrown completely back by the cartridge cases sticking, and we could not get them out?—On another occasion there was a trial at Shoeburyness between a brass gun rifled into a 9-pounder and a 9-pounder spherical-shot gun, and in 30 rounds I believe there were only a few seconds difference in the time.

100. (*Col. Taylor.*) The report of one trial is, that your gun fired 19 rounds in 25 minutes, but there were serious complaints as to the difficulty of extracting the metal cartridges, and there were numerous misfires in consequence?—Precisely; I remember that the instrument was lost, although it had been sent.

101. Do you not consider that that was not a fair trial, because the hole was not large enough and the misfires were very numerous?—That was so.

102. (*Col. Ormsby.*) At Shorncliffe with one of the heavy guns of 13 cwt. 20 rounds were fired in 13 minutes, and in the case of the Armstrong gun, in 15½ minutes; but the two light guns of 11 cwt. were much longer, one being 26 minutes and the other 28 minutes?—Yes; but very much depends upon the men. If the detachment had been changed, perhaps the results would have been different. I think, taking the same men, they would do it with a muzzle-loader more quickly than with a breech-loader, because there would be fewer operations.



103. (*Col. Simmons.*) Do you find with your form of shot that the bore in brass guns is liable to get injured from repeated firing?—No; I believe it will be found that the wear of the gun from the shot on the coming-out side is less than on the windage side, and that the gases wear the surface of the gun more than the rubbing of the shot.

104. Would that apply equally to both brass and homogeneous metal guns?—I do not know whether it would apply quite equally, but it would apply. The powder chamber is the part of the gun that wears; I have no hesitation in saying that as far as the rubbing of the shot is concerned, that part of the gun would wear out ten powder chambers.

105. (*Col. Taylor.*) It is just short of the seat of the shot, is it not, that the injury occurs; where the first expansion of the gas is arrested?—Yes.

106. Do you anticipate as the result of firing continuously with a brass gun rifled upon your principle, that it would be subject to drop at the muzzle, as was the case with the old brass field gun?—No; I think that the long bearing that it has in the gun will prevent that. In the old brass gun they used to have a good deal of windage, and there was a bite of the shot just on the head as it went out, but in the case of the rifled gun, I do not think you would find any dropping.

107. (*Col. Simmons.*) Your shot, from having a continuous bearing from the coming-out side, moves steadily out of the gun, whereas the spherical shot ricochet, and press down the bore?—Yes; I have heard Sir John Burgoyne say that he had many instances of the dropping of brass guns.

108. (*Col. Ormsby.*) After 500 or 600 rounds they begin to show it a little, although they are perfectly serviceable?—Yes.

109. Do you propose much alteration in the present field carriage for the 9-pounder or the 12-pounder?—No.

110. Nor in the packing of the ammunition?—No.

111. Is your mode of packing the ammunition the same as Sir William Armstrong's, that is to say, having the powder on the inside and the shot on the outside?—That I should leave entirely to circumstances.

112. (*Col. Simmons.*) Could you furnish the Committee with a tabular statement of those details, as to which I asked you in the earlier part of your examination, taking each description of gun or howitzer, and stating with regard to it, its weight, calibre, and length, the charge, the rapidity of twist, either in calibres, or in feet, or in inches, whichever would be better understood, and also stating whether it is a muzzle-loader or a breech-loader; and will you also furnish at the same time a table of the ranges, and the elevation of each description of gun for field service, and for each of the other services, classifying this information or not as you think fit?—I will do so with pleasure.

113. (*Col. Taylor.*) With respect to Shrapnells, have you a finished Shrapnell to submit to the Committee?—Yes.

114. Have you decided upon the precise form of Shrapnell shell which you would submit for the service?—Yes. I do not know what Colonel Boxer has been lately doing with it, but there will be some experiments to determine the proper elevation and the length of the fuze for particular ranges, which experiment has not yet I think been carried out.

115. In fact you leave the detail of that to Colonel Boxer?—Yes.

Adjourned to Thursday next at 12 o'clock.

Thursday, 8th January 1863.

PRESENT :

MAJOR-GENERAL RUMLEY, Inspector-General of Infantry.

COLONEL ORMSBY, R.A.

COLONEL TAYLOR, R.A., Commandant School of Gunnery.

COLONEL SIMMONS, C.B., R.E.

CAPTAIN PREEDY, C.B., R.N.

CAPTAIN SINGER, R.N.

MAJOR YOUNG, R.A., Director of Artillery Studies.

SECRETARY :—CAPTAIN DYER, R.A., Assistant Inspector of Artillery.

MAJOR-GENERAL RANDAL RUMLEY IN THE CHAIR.

SIR WILLIAM ARMSTRONG, C.B., examined.

116. (*Chairman.*) As the Committee are appointed to examine and report upon certain facts contained in a confidential communication which is before us, we are anxious to know what guns and ammunition you propose for the several services, and as field guns are first in order, will you state what guns you propose as field guns?—I shall be happy to give the Committee any information in my power, but I did not understand sufficiently early what I should be required to furnish, and therefore I have not brought with me all the drawings that I could wish; but when I ascertain more distinctly what the Committee require, I can furnish any drawings that they may call for; those which I have brought with me I have borrowed from the Ordnance Select Committee.

117. Will you furnish all the information which is required by this memorandum, so as to enable the Committee to report upon what is proposed?—I suppose that one example of each kind of gun will be sufficient. This (*producing a drawing*) is the existing field gun of the service. That gun, as there shown, I propose to produce to the Committee, but of course with all the newest improvements. There have been no guns of this pattern made for about a year and a half, therefore there has been no opportunity of engrafting upon this design the latest improvements.

118. How are we to report the facts upon this gun if we cannot see it?—This gun as it stands is the service gun, and you can of course use it as it is. As soon as I knew that this Committee was about to be appointed I applied for authority to have a gun made with all the latest improvements, and that gun is now in hand, and will be completed probably in about a month; but in the meantime there is no reason why any experiment which you wish to proceed with should not be proceeded with with the service gun as it stands. I should be able to point out two or three small points in which improvement would be desirable.

119. This is a 12-pounder, is it not, which you propose as a field gun?—Yes; and I propose a similar gun for the horse artillery, the 9-pounder horse artillery gun which is shown on this plan (*producing another drawing*), which gun you can see at Woolwich complete. In addition to these there are the 6-pounder, the 20-pounder, and the 40-pounder for field service.

120. In order to enable the Committee to arrive at the facts, a particular kind of gun must be named, so that any experiments which the Committee may desire may be made with it?—Just so; then I must send you a drawing of the 20-pounder as adapted to field service; but I have not got it here. Here is a 40-pounder gun (*producing another drawing*), which

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I suppose would in certain cases be used in the field as a gun of position.

121. (*Col. Ormsby.*) We have a 40-pounder now in the service, have we not?—Yes; if the Committee would allow me, I would rather take a list to-day of what is required, and then furnish them with the drawings.

122. (*Chairman.*) All that we are required to do is to report upon what you propose as contained in this confidential document, and will you be so good as to address yourself to the points which are there alluded to?—Then I must have a few days to prepare those drawings, because, as I have said before, I have only borrowed those for this particular day; I shall also produce a muzzle-loading field gun upon the shunt plan; it is not yet in the service, but I shall be able to show you the gun in the course of two or three weeks, and in the meantime I can give you the drawing; that is the projectile which you see upon the table.

123. Can you state any facts which you think important connected with those field guns?—I should be very glad to explain the mode of construction of those guns. The whole of those guns are upon what I call the coil system, which consists of forming tubes by rolling up iron bars in spiral coils and then welding them longitudinally; and when it is necessary to have a continuous tube joining them up in the end direction I use successive layers of tube until the necessary thickness is made up. That has now become, I think, almost the universal plan of constructing rifled guns which are required to be used with large charges; at all events, all the experimental guns which are being made for my competitors are being made upon that plan. Then as to the mode of breech-loading, I dare say the Committee will all be familiar with the construction of this gun, which consists of a powerful hollow screw behind through which the charge and projectile are introduced, after which the vent piece is dropped into its place, and then tightened up by the breech screw. The screw is turned by a running handle, which operates also as a hammer for tightening the parts, and for disengaging them. I may mention that the first gun which I constructed was made with a steel barrel, the other parts all being coiled, and that plan I continue to prefer to this day, assuming it to be practicable to get a material that I can depend upon; but in all the attempts that I have made I have met with so much disappointment in the use of steel, and so much uncertainty that I have been obliged to abandon it and confine myself to wrought iron; but so much progress is being made in the manufacture of steel suitable for this purpose, and I have lately myself been led to such improved methods of treating it in the way of hardening, that I fully expect the time is not very distant when the original idea of using steel for the barrel will be revived, and coil guns will be made as represented here, but with an internal tube of steel.

124. (*Col. Taylor.*) That is bored out of steel, is it not, instead of a wrought-iron core to the gun?—It would be bored out of soft steel, not out of wrought iron.

125. (*Major Young.*) Would this core be made out of the solid?—Yes; there are two or three modes of doing it. One is to run the steel upon a soft core of iron, in which case you would have a mere shell of steel; the iron is very easily bored out. Another plan is to take it in the solid and bore it; but there is very great difficulty in getting those steel blocks sound, certainly hitherto it has been quite impracticable; we get so many that are bad, that no dependence can be placed upon them at all. The amount of trouble occasioned by attempting to use steel has been prodigious, just from the uncertainty. I believe that steel properly made, and under conditions that will exclude uncertainty, is the proper material for inner barrels, and I have not the smallest doubt at the present moment, that steel vent pieces may be made which will bear anything. There is one exception to the use of the coil in the case of

those guns, and that is the piece in which the screw works, and which is called the breech-piece; upon that piece the strain is longitudinal, whereas in all the other cases it is transverse. In this case, therefore, a forged piece of iron, having the fibre running in the direction of the length, is used, and that is overlapped by coils. In the larger guns those layers are more numerous.

126. (*Col. Simmons.*) Is that principle of inserting a vent piece adopted in all guns?—Yes; in all. I think that at the present time we should be able probably (although I could not say so with certainty), to get steel of sizes large enough for inner barrels which would be pretty uniform; but every increase in diameter increases the difficulty. You have more uncertainty in getting uniformity throughout, and more liability to internal flaws. But I think that before long a perfect gun will be obtained with a steel barrel and overlaying coils. Then with respect to the mode of breech-loading this arrangement was the one originally applied for field guns (*producing a drawing*), but I always expressed my opinion that for large guns it would be desirable to have the movement from the side, so as to avoid the necessity of lifting this vent piece; and the first large gun therefore that I made, which was a 70-pounder, had the movement from the side, but it was found that the escape from the joint instead of striking upwards came out sideways, and was liable to scorch the men who were standing nearest the gun. It was also urged as an objection to that principle that if the gun were to be fired prematurely, the parts of the breech-closing apparatus would be blown out sideways, which would be much more serious than their blowing out vertically, and therefore the principle of side loading was for a time abandoned. I was quite sure that by time and experiment the objections would be got over; but as there was so much pressure for rifled guns at the time, there was no alternative but to apply this system to the larger guns as well; but while the larger guns were made upon this principle, I continued my experiments with the other plan, and eventually arrived at a construction by which the convenience of the side movement was attained in such a manner as to obviate all the objections which had been urged against it. In the first place a cup was introduced which absolutely stopped the escape, so much so that lucifer matches might be laid round the joint without being ignited; and in the second place an arrangement was made by which the vent hole in the gun remained closed until the breech closing parts were in their correct position, so that the gun could not be fired by any possibility until everything was ready. A gun upon that principle can be seen by the Committee, and it is that plan which I propose for all large breech-loading guns.

127. (*Capt. Singer.*) Including the 40-pounder?—I think with respect to the 40-pounder it is doubtful. I would only have it for those guns where the parts become inconveniently heavy. I think it would not be worth while departing from the existing construction so far as the 40-pounder is concerned—certainly not below a 40-pounder—but for all above 40-pounders I prefer the side movement always.

128. (*Col. Simmons.*) Is there a gun now in existence ready for practice with that arrangement?—Yes; I can show the Committee a drawing of it (*producing the same*). In this gun there are no projecting parts, and it is like a muzzle-loading gun, perfectly smooth on the outside. The breech-closing apparatus consists of two parts, a stopper to which a cup is attached, and a powerful wedge which supports it. This stopper travels in a groove, so that it goes in and out without the possibility of the cup attached to it coming in contact with anything that would injure it. In coming out it is arrested by the stop here which prevents its tumbling out, and in going in it comes in contact with the stop here (*describing the same*), which prevents its going too far, so that there is no possibility of doing it wrong. The movement of



the stopper is double. In the first place it slides to and fro, and in the second place it works upon a pivot here, so as to make the cup enter a certain distance into the gun. When that is done, the supporting wedge is drawn forwards, but if the wedge be not drawn perfectly home, or if the handle to which it is attached be not exactly in its right place, a bolt which passes upwards to the top is prevented from falling down, and until it does fall down this slide which works over the vent cannot be withdrawn, but the moment it is quite right this bolt falls, and the slide is at liberty to uncover the vent. In that way it is impossible to fire the gun until everything is perfectly right, but all that will be very much better understood by a reference to the gun itself. Here is a piece of a barrel made on the coil principle. (*The witness explained the construction of the barrel.*)

129. (*Col. Taylor.*) What reason do you assign for wishing to substitute for the coil system, as now used in the interior, a solid forging of steel bored out?—The steel will be harder, and of greater durability, although I have no reason to doubt the durability of the coil; but we should escape defective welds and even such little defects as you see in this barrel; steel is a more close, a more compact, and a more perfect material. The making of those barrels sound has been a matter of great difficulty, which was only overcome by very gradual steps. At first the imperfection of the iron caused many of them to be spoiled by blisters, and even now we are not wholly exempt from this liability. In the external coils defective welds are of little importance; but the inner tube ought to be very sound, and it is still difficult to get it perfect. We would escape those difficulties if we could make the inner tubes of steel.

130. (*Col. Simmons.*) Would not the steel present a harder surface than the iron, so as not to be liable to so much injury from friction?—With a leaden projectile even iron suffers no injury, and I have never seen an instance of its being injured by friction after having been used for a very great length of time.

131. Do you anticipate the same facilities for connecting the outer coil with the steel, as you have at present for connecting the outer coil with the wrought iron?—Yes, the only difficulty is the difficulty in the manufacture of the steel; that is the sole impediment, and has been all through.

132. Would not the inner coil be more liable to be twisted than it is now by the resistance of the shot passing out?—No, not at all.

133. Would not steel be more expensive?—It would be somewhat more expensive, but not much. It would certainly be more difficult to bore, and there would be more workmanship upon it, but still I do not think the difference of cost would be an impediment.

134. (*Col. Ormsby.*) Some guns which you saw at Shorncliffe gave way crosswise, and in one case about 14 inches, and in washing out the gun the water poured through it, how do you account for that?—When we first began to make those guns we were subject to very great difficulty; we did not succeed in making perfect welds; we used material that was liable to blister, and it was only after long continued experiment that we ascertained what kind of iron was most useful for the purpose. Those guns that you refer to are almost the very earliest that we made, and subject to those defects.

135. Perhaps you may remember that some of them gave way crosswise, and there was one that you saw that gave way longitudinally?—But that was one which had been bored out and a lining put in. In the earliest stage of the manufacture we were infinitely more liable to defective guns than we are at present, but that is the natural condition of things. We tried some of them to the utmost extent of proof, so that it is impossible to say that there is any general deficiency of strength. There may be some particular guns which are defective, but as a general rule there is no deficiency of strength, the 12-pounders are abundantly strong.

136. (*Col. Taylor.*) What is the proper charge-proof of a 12-pounder?—Two rounds of 3 lbs., and five of 2 lbs., but we have some guns which have borne some hundreds of proof rounds, and with shot extending the whole length of the barrel. I am sure that if you take a properly manufactured gun made upon this principle according to the present system, and with the advantages of the present experience, you will find it next to impossible to burst it; you may do what you like with it.

137. (*Capt. Preedy.*) Do you consider it stronger with a steel lining?—I do not consider it stronger.

138. (*Col. Ormsby.*) Then what is the advantage of it?—You have a more perfect bore.

139. (*Major Young.*) A large number of 9-pounders which I have been looking at lately appeared to have suffered by shells bursting in the bore, and the rifling had been damaged to some extent, though not very much; would this steel core obviate that?—Yes, entirely; there is no doubt that the steel would resist that entirely. The bursting of the shells in these 9-pounders was owing to the old pattern time fuse having been improperly used in combination with the new pattern concussion fuse.

140. (*Col. Simmons.*) How is the seat of the charge formed in your gun; to what extent is the gun rifled?—A certain length is left plain for the cartridge, and then a certain length is left somewhat wider than the general bore, but rifled with grooves half the depth. When the shot is inserted it runs up into this chamber, which is called the bullet chamber, so that the back of the shot terminates where the plain part commences, and the cartridge occupies the space behind. The rifling, therefore, extends with grooves of the full depth from the muzzle to the commencement of the bullet chamber, at that point the grooves are reduced to half the depth to the commencement of the powder chamber, and the remainder is plain.

141. Are the sides of the shot parallel?—It is a little larger at the back end, so that when it is run up it chokes upon the back end against the shallow grooves of the bullet chamber, and at the same time the forward end is brought into contact with the full rifling, therefore it meets the grooving at both ends at the same moment.

142. You fire always with the same charge, do you?—Yes, always with the same charge.

143. Do you never fire with reduced charges?—It is optional to do so, but the cartridge is only provided for the ordinary charge.

144. (*Major Young.*) Is it desirable to fill up the chamber when you fire with reduced charges?—No; it is desirable to have the cartridge the whole length, but it may be as small in diameter as you like. There is no objection to air space, but there is an objection to longitudinal space between the cartridge and the shot.

145. (*Col. Simmons.*) Is the chamber for the charge so calculated as to be exactly filled with the service charge?—No, there is a little space. It will hold 2 lbs., but I have always observed that greater uniformity of range is obtained by not completely filling the chamber; the powder is more equally consumed.

146. What proportion does your charge bear to the weight of the shot?—The service charge is one-eighth, as a general rule. I was led to adopt breech-loading for field guns in the first instance from the circumstance of that particular form of shot, that is to say, the lead coated projectile involving breech-loading, because the principle of this projectile is its being coated with a soft material, which is to be forced into the grooves, and therefore it is necessary to introduce it from behind, and make the barrel larger for its reception. It is impossible to insert it from the muzzle, therefore the use of this projectile involves the necessity of breech-loading. When this projectile was brought forward there was no other that gave results comparable to it, and there did not appear to be any alternative but to adopt for field guns the form of gun which was suited to a projectile of this nature.

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147. (*Col. Taylor.*) In fact it was a matter of choice between the *bal forcé* and the mathematical fit of the rifle?—Yes, but at the same time there are obvious advantages attending breech-loading in field guns. One advantage is that the projectile always goes home to its seat, whereas if you load from the muzzle, if the slightest impediment occurs, you would be liable to have the projectile left part of the way down the bore, in which case there would be very great risk of the bursting of the gun. In fact it is very well known, I believe, in the case of small arms, that a great many barrels are injured from that cause, namely, that the men do not ram the shot home, and the consequence is that when the gun is fired distension takes place at the back of the projectile, a liability which you altogether escape in loading from the rear; and you also escape the liability of having an accident from the gun being fired before the man at the muzzle gets out of the way. There have been many instances of men losing their arms by the guns being prematurely fired. But the advantages of breech-loading are not nearly so obvious as applied to field guns as they are with regard to guns of a larger calibre. In the case of ship guns it enables long and powerful guns to be used in small ships, because it is not necessary to run a muzzle-loading gun in-board in order to get at it for the purpose of loading; and in casemates also it is very obvious that the loading from behind presents very great advantages; in fact it must be, I think, clear that it is the great desideratum to have a good breech-loading gun for naval purposes and for casemates, but for field purposes I consider it is of less importance. I have always considered it a matter of choice for the service rather than a matter of design with me whether a breech-loading gun or a muzzle-loading gun should be used. So long as this projectile was used a breech-loading gun was indispensable, but I have for the last year and a half been experimenting with muzzle-loading guns, and the plan I have adopted is applicable to field guns as well as to large guns. The principle of rifling I have adopted for those guns is that which I have called the shunt principle, and in that principle I have endeavoured to conform as much as possible to the principle of this lead coated shell, that is to give the rotation by the use of a soft material, which shall have the property of self adaptation so as to distribute the strain over the whole of the grooves, and which shall also suffer a certain amount of compression in the bore of the gun, to take off all vibration and deliver the shot with perfect steadiness. The projectile of such a gun is this (*pointing to a shell*). It would be internally the same as the lead coated segment shell, but instead of using an entire coating for the purpose of giving the rotation I use six small brass studs, which are very easily stamped into the projectile. If these studs are not mathematically at right distances those that are most prominent will yield a little and allow the others to come up and get a perfectly equal bearing upon the whole. The grooving is so arranged that the projectile shall enter perfectly free, but in coming out it hugs the opposite side, or driving side, and in so doing it meets with an inclined plane lessening the depth of the groove towards the muzzle, so that by the time it arrives near the muzzle, those soft projections are in contact with the bottom of the grooves, and suffering a certain amount of compression, which compression takes off all shaking from the projectile and it is delivered quite steady.

148. (*Col. Simmons.*) Are the abrasions from those brass studs liable to rest in the grooves and foul them?—No, not all.

149. Have you had much experience with this projectile?—A good deal with the larger guns, but not with the smaller ones. We have had very good effects where it has been tried. I should mention that the projectiles used were somewhat different from that now proposed, although the same in principle.

150. (*Major Young.*) Is not this very much like the French system?—The only difference is this,

that in the French system the studs are made of zinc, and a good deal larger. The shunt arrangement is also wanting in the French gun, and the interior of the shell is quite different.

151. (*Col. Taylor.*) The case containing the segments in this proposed shell is of iron, is it not?—Yes, exactly the same as in the other.

152. (*Col. Simmons.*) What is the number of fragments in that 12-pounder shell?—They burst into about 200 pieces. There are 49 of those segments in a 12-pounder.

153. (*Col. Taylor.*) What is the expense of one of those shells?—I think the 12-pounder with its burster and with the concussion fuse and the time fuse is about 6s.

154. The last price that was furnished me for the 12-pounder segment shell on the 20th of November 1861 was 5s. 3d. not including the concussion fuse, which may be supplied at about 10d?—I think 6s. is about the price of the whole.

155. I think that was the price at the time of the Ordnance Committee, but they have been reduced since then have they not?—Very likely, I think 6s. is the present cost.

156. (*Col. Ormsby.*) Do you recommend the principle of muzzle-loading or breech-loading?—All that I can say is, here is a good breech loader and here is a good muzzle loader, and it is a question more for the service than for me to say which is the proper gun to use. I produce a good gun of both forms, and the service must make their own choice.

157. Is the weight of the muzzle loader and the breech loader the same; namely 8½ cwt.?—Yes, they are both the same.

158. (*Capt. Preedy.*) Could this shell which you have been describing be used both ways?—Yes.

159. (*Col. Ormsby.*) With regard to the vent pieces as you make them now, is there much danger of their breaking?—Not the least with the field gun.

160. (*Col. Taylor.*) Do not you believe that you could fire that shell with the common service fuse if necessary?—I am not sure whether it would do or not, I have never tried it; I dare say it would, but I should prefer the other fuse.

161. (*Col. Ormsby.*) A great number of our fuses are very bad and unsafe; are they the same as now in the service?—You had the very earliest fuses that were made, and they required very careful packing, in order to exclude the moisture; but that is entirely obviated now. Here is the present service fuse (*producing the same*), which you can let lie under water. If you look at it you will see that it is entirely water-tight; whereas the original ones required external protection.

162. Are these fuses in the service now?—Yes; they are in the service now; they are the latest pattern fuses.

163. (*Col. Simmons.*) In your system of breech-loading, you are dependent entirely upon percussion fuses, are you not; or do you use time fuses?—I use time fuses.

164. How do the time fuses ignite?—On the detonating principle. I can show it you by a specimen (*the witness explained the same*). I may observe, that there is a great difference of opinion as to what the calibre of rifled guns should be. The large calibre has the advantage of enabling a shell to be used with a great capacity for powder, and also in a less elongated form, so that the projectile's effect is greater. The small bore has the advantage of affording greater penetrating power, and giving a more extended range, because the atmospheric resistance is small; but the damaging effect of a lengthened projectile of small diameter is comparatively little. That is one of the points of difference between Mr. Whitworth and myself. Mr. Whitworth, with the view of getting greater penetration, and a greater range, advocates a small bore and an elongated projectile, whilst I, on the other hand, with the view of getting the greatest possible effect, advocate comparatively large bores. With regard to the mode of rifling, it



does not appear to me that there is any particular advantage in one system over another; so long as the requisite rotation and steadiness are given, it does not appear to me to make any difference, whether you give it by grooving, or by polygonal sides, or by any other form; a projectile of certain proportions requires a certain rotation, and it is a matter of indifference how you give that rotation. There is one observation which I should make with reference to my earlier guns, and that is, that they were designed at a period when the system of plating ships with armour had acquired very small importance; they were consequently adapted chiefly, or almost exclusively, for operating against timber ships and forts, and such things as large guns dealt with at that time. The recent general adoption of armour plates has produced a new phase in gunnery, and it now becomes necessary in consequence to use guns of very much greater power and very much greater weight, and it cannot be expected, I think, that guns which were designed without reference to action upon armour plating, and designed also for throwing cast iron projectiles of the ordinary construction, and not steel projectiles, should be of much avail against armour plated ships. Recent experiments however have shown that where the weight of the projectile and the charge are the same, the effect upon iron plates is greater with a rifled gun than it is with the smooth bore gun. I do not think it is sufficient merely to pierce small holes and tumble a few exhausted shot into a ship, what you want is a great crushing or a great shattering effect, so that a single shot taking effect upon the side of a ship shall endanger the existence of the ship, but I am sure that in order to produce effects of that kind you will require guns of immensely greater power than are now in the service. My own opinion is that the navy will have to make up their minds to use guns of very much greater weight than they at present contemplate. I have to submit to the Committee a gun which I consider effective against plates, that is a gun throwing a projectile of about 300 lbs. and weighing 12 tons. That gun is upon the shunt principle. It will be provided with projectiles both for use against ordinary objects such as forts and wooden ships, and also with steel projectiles, and shells in particular, available against iron plates.

165. (*Col. Taylor.*) Have you a steel gun ready?—I have a 12-pounder with a steel barrel. It is very nearly completed.

166. (*Col. Simmons.*) What is the calibre of the 300-pounder?— $10\frac{1}{2}$  inches, and it throws a steel shell containing a bursting charge of 12 lbs. to 14 lbs.

167. How many calibres is the length of the shell?—About two calibres.

168. What is the rapidity of the twist?—The rapidity of the twist is one turn in 65 calibres. There is another point to which I would wish to draw the attention of the Committee in reference to the calibre of guns, and that is that guns with a large bore always afford a higher initial velocity, and I believe you will find on comparing Mr. Whitworth's guns and mine, that I, in consequence of the larger bore, attain a higher initial velocity, but, in consequence also of the larger bore, I do not maintain that velocity so long, because the atmospheric resistance is greater, but I start with a higher velocity.

169. Do you mean with the same charges relatively to the weight of the shot?—Yes; and the reason is simply this, that the effect of the powder upon the projectile in giving velocity is dependent upon the number of expansions which it makes before it ceases to act. If you suppose the bore of the gun to be 10 times the capacity occupied by the cartridge, the powder will expand to 10 volumes before it ceases to act; but if it is only five times the capacity, it will only expand to five volumes; and in expanding to five volumes it will impress much less effect upon the projectile, than if it expanded to 10 volumes, therefore with guns equally long, and using equal charges, you get a much greater expansion with a

large bore than with a small bore, and therefore you get a higher initial velocity. You can compensate that by having an extremely long gun, but then considerations of convenience preclude your having a gun of excessive length.

170. (*Col. Taylor.*) You may pass the limit, may you not, by increasing the length of the gun?—Yes.

171. But if you get beyond a certain point, there your increased length would diminish your velocity?—It must be of very great length to do that.

172. (*Col. Simmons.*) Do you find that there is much difference between the initial velocity of your shunt gun and of a gun rifled upon the grooved principle?—No.

173. Is there much loss of velocity from the force that is used in compressing the lead?—No, none at all, or at least nothing appreciable. In fact it is rather a curious circumstance that as you increase the thickness of the lead, and give a greater amount of that compressive action, you rather increase than diminish the initial velocity, and the reason is that the shot is checked in its movement forward until the powder has been more perfectly consumed behind; the powder is more perfectly gasified owing to the detention of the shot at the start; but you will observe that the forcing action is not a continued friction all through the bore, it is merely the first movement in pressing the projectile up to that point at which the rifling of the lead covering is perfected.

174. Probably about its own length?—Yes, about its own length. After that it is perfectly free to move, more especially as the gun is ground out a little wider after that short length.

175. (*Col. Simmons.*) If the combustion of the powder is more complete in the chamber, do you find that from the force exerted upon it the chamber deteriorates or expands at all?—No, we have no instance of any deterioration taking place there.

176. (*Major Young.*) Would there be any advantage in making use of different descriptions of powder, for instance, using cake powder, Brown's, which is used in America, instead of the powder which we use in flannel bags?—In small guns it would not make much difference, but in large guns it would be desirable to use it in a very large grain. There is great variation in the strength of the powder now used. The regular service powder varies by keeping; the old powder has different strength from the new powder, and when you make cartridges up indiscriminately without making them from the same samples, you get a very considerable variation of range. In any trial which you make with those guns, it is important that you should use powder of the same date and manufacture.

177. (*Col. Ormsby.*) The old powder is not what we call Armstrong powder, I believe?—No.

178. Would using the A<sub>4</sub> powder make much difference in the shooting of your guns?—I think the A<sub>4</sub> is better than the old powder, but there would not be much difference.

179. (*Major Young.*) Can you account for the peculiar effect of that 2 A<sub>4</sub> powder?—I think it is much more rapid in its action; but you might use it with perfect safety if you did not put the shot quite home, but stop it at a small distance from the bottom; and if you used an elongated cartridge.

180. (*Chairman.*) Will you describe the shell which is on the table before you?—This is a 70-pounder shell for a shunt gun; it was designed with the view of preventing any contact between the rough cast-iron surface of the shell and the bore of the gun; that is to say, that it should be in the same condition in that respect as the shot which was entirely enveloped in lead, that there should be nothing but soft surfaces rubbing upon the bore, for which purpose pieces of zinc were inserted between the driving ribs all round, and also a certain number behind (*describing the same*). Another set of ribs were inserted, also of zinc, for the purpose of giving rotation, so that you have two sets of zinc ribs, one acting as bearers and the other acting as drivers.

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That shell makes very good practice, and is just as innocuous to the barrel as a leaden projectile; but I begin to think with the very beautiful castings which are now made, there is nothing to fear from the contact of the rough surface. I think that those ribs may be dispensed with, and from experiments that I have made lately I am sure that we shall get quite sufficient driving power from a small number of brass studs the same as we have in this shell (*pointing to another shell*), and the construction will be very much simplified. The steel projectiles which I am making for small as well as for large guns, are provided with brass studs. This part of the shell (*describing the same*) is left open to allow the gas to get thoroughly round past the ribs, because I found, from some cause which I can hardly understand yet, that we were liable to get the pressure of the gas upon one side, tending to cause excessive friction upon the opposite side.

181. (*Major Young.*) Are those studs a prolongation of the other part of the shell at all?—No. This projectile with the ribs certainly makes excellent practice; but I believe that we shall attain the same results with this simpler form of construction. That in which studs are used is about the simplest form of projectile I can imagine; it is cast in a manner which secures almost absolute accuracy, and these studs are stamped in by an arrangement which prevents any deviation from the true line.

182. Have you made any experiments with this shot?—Not with this particular one; but with others with studs I have.

183. (*Capt. Singer.*) Is the line of these studs in line with the axis of the shell, or at an angle?—At an angle.

184. (*Col. Simmons.*) Do you find much difference between the abrasion of the studs which are below and those which are above?—No, none at all. The weight of the shot is nothing in comparison with the side actions which are in operation.

185. (*Capt. Preedy.*) Is there any possibility of a portion of them being left behind?—No.

186. (*Col. Ormsby.*) Are the large 70-pounder and 100-pounder shells built up in the same way?—Yes, all on the same principle.

187. The shells of the larger guns are different from the shells of the smaller ones, are they not?—No, this is a common shell, and there is also a segment shell to fit all the guns.

188. (*Col. Simmons.*) Have you any rule as to the length of the shot as compared with the calibre of the gun?—Not a very definite rule. For a shell I should say generally speaking that about  $2\frac{1}{2}$  calibres is as good as anything you can have.

189. And for shot how is it?—For shot it is always difficult to get it long enough, without making the bore too small.

190. Have you any expression for “the rapidity of twist” in your rifles?—For field guns I think about 1 in 38 calibres is the most favourable. For the larger guns it should diminish somewhat, but it is an exceedingly complex question to determine what should be the proper twist. I have investigated it in every way with the best assistance I could obtain, and I think I am pretty nearly right in giving to the large gun, the 300-pounder, one turn in 65 calibres.

191. (*Col. Ormsby.*) Has it an equal twist at the breech and at the muzzle?—Yes, it is equal throughout. There are two causes of unsteadiness. There is, first, the eccentricity of the centre of gravity which causes the pressure of the gas acting upon the base to produce a lap sided action at the instant of the shot quitting the gun. There is also a tendency to unsteadiness from the resistance of the air in front operating upon the head of the projectile, and tending to turn it over. In dealing with the first cause of unsteadiness it is desirable to have the centre of gravity far back, in dealing with the second cause it is desirable to have it far forward. My own impression is that the greatest steadiness is obtained, contrary to the received opinion, by putting

the centre of gravity backward instead of forward, because I think that more harm is done by the kick which the shot receives as it leaves the gun than by the tendency to turn over which is due to atmospheric resistance.

192. (*Col. Ormsby.*) Does that shot always go end on or in a sideways direction?—It goes end forward, but whether it follows the curve of the trajectory is a very difficult question to decide; theoretically the direction of the axis should not be simply tangential to the curve, but judging by the eye when the projectile is fired with a low velocity it certainly appears to be very nearly so.

193. (*Major Young.*) To return to field guns, with reference to a common shell, do you propose any common shell to be fired from field guns?—I am prepared to produce a common shell if it is thought necessary; but that again I think is a military question, which is more for the service to decide than for me. I can produce one, but I have never been called upon to produce one yet. There is a common shell with the 20-pounder; but whether it is worth while to use a common shell with so small a bore as that of the 12-pounder is a question which I cannot undertake to give an opinion upon.

194. Have you not thought of a howitzer gun of large calibre?—I have thought of a short 20-pounder, which is a gun that I think ought to be used as a howitzer; it is about 13 cwt., and it throws a common shell containing 1 lb. of powder. I have also proposed a 7-inch howitzer for siege and garrison purposes.

195. (*Col. Taylor.*) Are you aware of the proposal to have batteries attached to the army having a shell gun, and calling it a shell battery?—I was not aware of that proposal; but I quite concur in the propriety of it. I think it is very important.

196. (*Col. Ormsby.*) With regard to the muzzle-loading gun, when will that be ready?—Almost immediately; in 10 days or a fortnight. But you will have plenty to go on with if you propose commencing your experiments immediately, because, of course, you will try the breech loader.

197. We first want to see what is proposed?—I can show you what is proposed, but you will not have the gun before you; you can have an accurate drawing of it next week, and you shall have the particulars of it by Monday, certainly.

198. (*Chairman.*) Is there anything else that occurs to you at this moment which you wish to state to the Committee?—Not at present; but if anything does occur to me, perhaps the Committee will give me an opportunity of stating it.

199. (*Col. Simmons.*) In the course of the explanation which you have given us with regard to the construction of guns, you spoke of lining them with steel; are you aware that steel guns are used in the Prussian service?—I am quite aware of it.

200. Are you aware whether they have been liable to injury, or whether they are insecure, or whether the manufacture of steel in Prussia is so certain that those guns can be depended upon?—I think steel has only been used extensively for small guns, and there I do not think there is very much difficulty; but I have no means of ascertaining what number of failures they have had; on the continent they are so reserved that it is exceedingly difficult to get any certain information. We have tried the Prussian steel in this country, and up to the present time it has been anything but satisfactory, several guns which have been tried made of the same steel as they are now using in Prussia have failed at proof, and it must be borne in mind that much lower charges than ours are used; the Prussians are using charges of one-tenth and one-eleventh, and we are using one-eighth the weight of the projectile.

201. Do you know the relative weight of the steel gun as compared with the coil gun?—It is about the same; the recoil determines the weight of the gun.

202. Their system of rifling is similar to your own, is it not?—It is just the same.



203. And their system of breech-loading?—Very similar; the projectile is introduced from behind, and it is a lead-coated projectile.

204. (*Col. Taylor.*) It is a misnomer, is it not, calling the wedge gun a side-loading gun, because it is loaded the same as the other; it is only that it is stopped at the side?—Precisely; I do not think that the term has been quite properly considered. When you speak of a steel-lined gun, it must not be understood that I propose a mere lining within the gun as now constructed, but the substitution of an inner barrel of steel for the present inner barrel of wrought iron; not putting a steel lining into the inner barrel, but taking the inner barrel out and putting in, in substitution, a steel barrel.

205. (*Col. Simmons.*) Practically, it would be a steel lining, would it not?—It is no more a lining than the inner barrel now is a lining; I mean, that it would not be putting in a thin shell of steel within the gun as it is at present. If you call the inner tube the barrel, then it is using a steel barrel with superimposed coils.

206. Do you propose to apply it to all sized guns, small guns as well as large?—I propose it thus far, that as soon as we see our way to getting a proper material without risk of failure, and at the proper cost, I think probably it would be available for all forms of guns; but I think it is more important in the large guns than it is in the small ones.

207. (*Col. Taylor.*) With respect to the recent trials which have been made for toughening the metal for the vent pieces, have any further experiments been made with it, or have those which have been made satisfied you that the process will render the vent pieces perfectly secure?—I can only say this, that a vent piece so treated is all but indestructible under the hammer; we have not tried them with actual firing yet, but the difference between the raw steel vent piece and the toughened steel vent piece, as tested by blows, is enormous.

208. (*Col. Simmons.*) Are there cases on record of a piece of the inner tube turning within the outer tube in your guns?—I think not. I do not recollect anything of the kind. In many of the early guns, when we had so much difficulty in making the inner barrel sound, we introduced a thin lining, and those guns stood perfectly well at proof; but for the most part, since then, they have become imperfect, under continued firing. Some of those guns, that is to say, some of those thin linings so introduced, did actually move a little at proof; but then that was obviously owing to their great thinness, rendering them unable to support the pressure of the external coils, and the bite upon them not being sufficient to resist the action. But with a gun constructed in the ordinary way, and not cobbled by the introduction of a thin lining, such a thing has never occurred.

209. In point of fact, among the guns as now turned out from the factory, you have had no such results?—No; they are perfectly exempt from that; it is only in patched guns where it has taken place, and then only in one or two instances.

210. (*Col. Ormsby.*) In two of the cases in which it did occur, the inner lining moved forward, and in one case it moved back?—There is no doubt that it is quite unsatisfactory to patch a gun in that way; if we have a bad barrel now, we reject it altogether; but we expected at that time that we were making rather a better job of it. We could only judge by what the guns stood at proof; but experience has shown us that we cannot depend upon trials of single guns at proof; when you come to make a great number, and get them into extended use, defects are exhibited which were never dreamt of before.

211. (*Col. Simmons.*) There have been reports that the vent pieces have blown out; could you explain to the Committee any cases, or the causes which have produced such results?—I think I can. This drawing (*producing the same*) shows the vent piece as it is now constructed; but in the original plan the vent

piece had a flat back without this projection; it has now a projection, which enters so far into the screw (*describing the same*), and, therefore, you will easily see that no force could possibly get it out if it is screwed up. We have even found that if not screwed up, the effect of this projecting piece here (*describing the same*) is to prevent its coming out; but in the absence of that projection, if you neglected to screw up the breech properly, the escape of the gas produced a pressure underneath the vent piece (especially in the early guns, which had only small holes below instead of large holes, as now adopted), and threw the breech-piece out. There is another cause: if you drop the vent piece loosely into its place, and leave it to take care of itself, and then turn screw until it will move no further, it is impossible that the vent piece can come out; but the men are very liable to keep hold of it, and not allow it to go down, and the consequence is, that its face, instead of being opposite the corresponding chamfer, is resting against the flat end of the gun; consequently, when the screw goes up, it merely nips it in between those two surfaces, and there is nothing to prevent its coming out; that is owing to the men not leaving go of it when the screw is in the act of being screwed up.

212. (*Col. Taylor.*) Most of the accidents which have occurred are referable, are they not, to the men keeping hold of the neck of the vent piece with their fingers while they are screwing it up?—Yes; but if you have this projection behind, and this large hole below instead of the small one which you had before, it is almost impossible to blow the piece out.

213. (*Col. Simmons.*) In those later guns which you have made there is, I presume, this projection in the rear of the vent piece, and there is also a larger hole?—Yes.

214. Have you had any cases of the vent pieces blowing out with guns so constructed?—No, not one. Only they have not been very extensively used. I have not heard of a single instance of a vent piece blowing out of 9-pounders, which are made upon that principle.

215. (*Capt. Preedy.*) Would the circumstance of the cup which you place in after the charge not being pushed further up interfere with the action?—No, I must mention that the screw of the 12-pounder admits of improvement. It has a square thread, different from what we now use, and the leading portion of the thread is found liable to break. With the new pattern screw this never happens. The screw also requires to be a little reduced in diameter, on the plain part next the vent piece, as the fouling settles on this part and makes the screw stiff to work, unless a little water be applied. A mere shaving taken off would rectify this fault.

216. (*Col. Simmons.*) I presume in the later guns that has been done?—Yes.

217. There is another point which I should like to ask you about, which perhaps you can explain to the Committee. It has happened that some of those vent pieces have been destroyed, that is to say, they have split or broken, could you state in what way they go and the causes of their failure?—All the early vent pieces were made of steel, and they were subject to excessive variation in quality, and the consequence was that all the bad ones failed. After we ceased to use steel we were not fully aware of the best kind of iron to use for the purpose, and some small number of the iron ones, but very few, have also failed, but they have not broken, they have merely bulged or cracked and become unserviceable. They have not gone into pieces as the steel ones did; therefore it is a less serious evil with a wrought-iron vent piece than with a steel one. Lately we have by gradual steps arrived at the best quality of iron, which undoubtedly is a quality of Swedish iron. With ordinary firing with service charges at proof we have not had a single instance of the failure of one of these, but a perfect vent piece would be that which we now contemplate, which is a vent piece

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of mild steel of a very superior manufacture, and tempered in oil. That I have every reason to believe will be absolutely proof against any amount of force. 218. Will it be necessary to face that steel with copper now as in the present vent pieces?—Just the same in that respect, but where copper is used no cup is required.

219. (*Major Young.*) What is the objection to copper facing for large guns; the 100-pounder, for example?—The wear is much greater in the large guns than in the small ones.

220. (*Captain Singer.*) Have you ever heard of an instance of a gun which continued firing so long that it became so hot that the outer coil got slack?—

No, I think it would have just the reverse effect; heat applied to the inside would cause the outer coils to tighten.

221. On cooling I mean?—No, certainly not, the cooling would be so gradual that there would be no sensible difference in the temperature; it would require a difference of 300° or 400° to slacken the coils; in fact we find it a most difficult thing to get the coil off when we want to do so.

222. In steam cylinders they occasionally meet with that difficulty, do they not?—Yes, where the jackets are used there is a little tendency to that, but the cases are quite different.

Adjourned to Monday next at 12 o'clock.

Monday, 12th January 1863.

PRESENT :

MAJOR-GENERAL RUMLEY, Inspector-General of Infantry.  
COLONEL ORMSBY, R.A.  
COLONEL TAYLOR, R.A., Commandant of the School of Gunnery.

CAPTAIN PREEDY, C.B., R.N.  
COLONEL SIMMONS, C.B., R.E.  
COMMANDER SINGER, R.N.  
MAJOR YOUNG, R.A., Director of Artillery Studies.

CAPTAIN DYER, R.A., Assistant Inspector of Artillery, Secretary.

MAJOR-GENERAL RANDAL RUMLEY IN THE CHAIR.

Master Gunner SAMUEL COX examined.

Master Gunner  
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223. (*Col. Taylor.*) You are Master Gunner at Shoeburyness, are you not?—Yes.

224. How long have you held that appointment?—About nine months, and conductor of stores 11 months, similar duty to that of Master Gunner.

225. Previous to your appointment of Master Gunner what situation did you hold?—That of Serjeant Instructor of the experimental establishment.

226. And as such you assisted the then Assistant-Superintendent in carrying out all the experiments, did you not?—Yes, generally speaking I did.

227. You held that appointment at the time of the introduction of the Armstrong gun?—Yes.

228. And you assisted in carrying out the greater part of the practice that was first made with it?—A part of the practice.

229. What was your impression as to the value of that gun as compared with the ordnance then in existence; did you consider it a great improvement on the old or not?—A great improvement on the old.

230. You had never seen such long ranges attained before?—No.

231. Nor such precision?—No.

232. Did you experience any difficulty in the working of the gun at first?—No.

233. Do you remember any accidents by which injury was done to anybody with those guns?—No.

234. And should you say, from your experience of the handling of that gun, that there was any very great difficulty to overcome in instructing the men in the use of it?—None whatever; it requires care on the part of the instructor.

235. You, of course, have seen a great deal of practice with the new fuse introduced with that gun—with the segment shell and fuse?—Yes.

236. And what was your impression as an artilleryman of that description of shell and fuse as to its efficiency for field purposes?—They were much superior to any that I had ever seen.

237. Supposing you were with one of those guns in the field, at what range do you consider that a good artilleryman ought to be able to put the whole of his fire into the front of a column of companies?—At 3,000 yards.

238. Do you consider that the amount of intelligence required to understand and handle the fuses is such as to require specially instructed men, or do you think that with the average of the gunners that come under

your care you could have instructed them to prepare that fuse?—Yes, I think I could.

239. If you yourself were asked to undertake it now how long would you require to take a detachment of completely uninstructed gunners (I mean recruits—men who have learned nothing), and make them a competent detachment for a 12-pounder Armstrong gun?—I could do it in three weeks.

240. (*Col. Ormsby.*) Do you mean from the raw recruit?—After he has been a certain time, and is set up in his drill; after he has disposed of his first probationary drills—his marching and carbine drill.

241. (*Col. Taylor.*) To the duties of what number do you consider that any danger attaches in the use of that gun; is there any number whose neglect of his duty is dangerous?—No. 2 is the one whose neglect I consider to be dangerous.

242. Is there any other number whose neglect could cause an accident to the gun, or upon whose correct performance of his duty depends the safety of the gun detachment?—Yes, No. 1.

243. I mean of the working detachment?—No; I do not think so.

244. Will you state what the duties of No. 2 are, and how the neglect of them would be dangerous; what is his share in the loading of the gun?—He unscrews and screws up the breech screw, takes out the vent piece, and drops it in.

245. And what act of neglect would cause danger?—The vent piece not being screwed up.

246. (*Col. Ormsby.*) That occasions danger, does it not, to the other men, as well as to No. 2?—Yes.

247. (*Col. Taylor.*) How would you describe the danger which would ensue, in the event of his not screwing his vent piece properly up?—With the new pattern vent piece, I do not think there would be any danger at all, if it was not screwed up properly.

248. What is the difference between the new pattern and the old?—There being a projection on the back of the centre of the vent piece, the hollow of the breech screw fits into it, and prevents it coming out.

249. (*Major Young.*) There would still be a blow given on the breech screw?—Yes.

250. And that would be liable to injure the thread of the screw?—Yes.

251. (*Col. Taylor.*) Have you seen vent pieces blown out under the old pattern, when there was no protection?—Yes; I have seen one or two.



252. You have never seen the vent pieces blown out since the projection has been added?—I have not seen one blown out.

253. (*Col. Ormsby.*) Have you seen the vent pieces break, crack, or injure?—Yes; but none of the newest pattern for the 12-pounder gun.

254. Have you seen them damaged in the slightest degree?—They have not been in use long enough to prove that.

255. (*Col. Simmons.*) In what way do those vent pieces generally give, when they do give at all?—They give in all ways. Sometimes they split in two; at other times they go in three pieces; sometimes the neck of the vent piece, or the upright part of it, is blown off only, and the other part left entire.

256. (*Chairman.*) Has what you have stated reference also to the new vent pieces?—No; they have only been in use a very short time.

257. (*Col. Taylor.*) Do you as an artilleryman consider it as an advantage or not, to have one form of projectile which can be adapted to different purposes; do you consider it better to have the projectile as in the Armstrong gun, to be used as a shot, or shell, or case, or to have three separate descriptions of ammunition?—I decidedly prefer one description.

258. (*Col. Ormsby.*) You think that better than having the shell gun in the old way, as we used to have in a field battery, two howitzers and four guns?—Yes, I think it better to have them all of one description.

259. (*Col. Taylor.*) Do you not recognize in the Armstrong battery the want of a gun for firing a common shell; at present you have no shell but the segment shell with the Armstrong gun, do you not consider that it would be an addition to the Armstrong battery if it could fire a shell with a 12-pounder field gun?—That certainly would be an addition, but so far as my opinion goes, I think that it would be advisable not to mix them.

260. (*Col. Simmons.*) You stated that there was no difficulty in training recruits to the use of the fuse, which fuse were you alluding to, the time or the concussion fuse, or what nature of fuse?—To both.

261. (*Col. Ormsby.*) In fact you are referring to the new Armstrong fuse?—Yes.

262. (*Col. Simmons.*) Have you known any of the breech screws of the field guns to be damaged in practice at Shoeburyness?—Yes.

263. How do they get damaged, in what way does the damage show itself?—The thread becomes detached from the body of the screw.

264. Is it stripped?—Yes, perhaps two or three inches at the end of it.

265. Do you find that in a casual screw now and then, or do you find that every screw is liable to it after long use?—They are all liable to it after long use.

266. Have you had a large number of them that have failed in that way at Shoeburyness?—I could not say the number.

267. (*Col. Ormsby.*) After a few inches of the thread of that screw has become detached from the breech screw, have you not found it work just as well?—Equally as well.

268. Have you ever found after firing 40 or 50 rounds that it required two men to screw up the breech screw of a 12-pounder?—No.

269. You have not found it fouling from the heat of the gun, and the quick firing and the little expansion?—We have generally used a little water or oil to prevent that occurring.

270. Have you never found that it required two men to screw it up?—We never allow it to get so bad as that.

271. After how many rounds of quick firing do you apply that water or oil?—We generally put a little on after about 20 rounds, or so.

272. Have you found the vent in the vent-piece choke much, and so causing mis-fires?—No, not at all.

273. Have you ever found it choke just at the shoulder of the angle after several rounds of quick firing?—I have noticed such a thing, but not very frequently. I may say very seldom.

274. (*Capt. Preeedy.*) If you had no means of obtaining water or oil, by continued fouling would the gun be rendered unserviceable?—No.

275. How would you remedy that?—We would take the screw out and clean it before we fired a sufficient number of rounds to make it so foul.

276. In what time could you do that without the aid of water or oil?—In two or three minutes.

277. (*Col. Simmons.*) Could you take it out and replace it and clean it in two or three minutes?—Yes.

278. (*Commander Singer.*) Have you never known the thread of the breech screw spring from the body of the screw so as to render the breech screw unserviceable?—I have known one that was in use a long time become unserviceable through the threads becoming detached from the body of the screw.

279. Are you alluding now to the square thread or the bevilled thread?—To the square thread, which is in all the 12-pounders.

280. Have you never seen a bevilled thread in a 12-pounder?—No.

281. (*Col. Ormsby.*) Have you found the tangent rings that fasten on the breech sights get loose after firing, and thereby make it liable to have an error in the elevation?—Yes, they do get loose after a few rounds.

282. (*Commander Singer.*) Have you never known the pins that keep the tappet ring on to the screw drop out in practice?—Very seldom.

283. The tappet ring rests in a kind of groove that goes through the pins, and the edges of this groove are sharp; have you ever known from the jarring of the firing the edges of the groove in which the tappet ring rests to become so burred that the ring would not move, and that you could not turn it?—Not with a 12-pounder gun.

284. Have you any objection to the Armstrong gun?—None.

285. Is there no alteration which you would wish to see effected, as to its length, for instance?—No.

286. (*Major Young.*) Do you like the breech-loading system for a field gun as well as the muzzle-loading system?—Yes.

287. Have you any particular reasons for saying that you prefer it?—No, I have no particular reason.

288. Can you state any advantages which you think the breech-loading system possesses over the other for field purposes?—No.

289. (*Col. Ormsby.*) Do you think that if the sight in the Armstrong guns were shot away or became damaged in any way you could make as good practice as we used to do with the old 12-pounder gun?—Yes.

290. Could you lay it as accurately?—We should still have the sights on the top of the gun to fall back upon in case of the side ones being shot away.

291. Do you think there is much difference in the rapidity of firing between the breech-loading and muzzle-loading rifled gun?—A very trifling difference.

292. Which has the advantage?—I should think that the preference would be for the muzzle-loading gun for rapid firing.

293. You have not had much practice with the Whitworth gun, I believe?—Not much.

294. Taking everything into consideration, from what you have seen of the two guns, the Armstrong and the Whitworth, if you were going on service and had the command of a battery and had your choice, which would you take?—I should take the Armstrong gun.

295. (*Col. Simmons.*) Why would you prefer the Armstrong gun?—The projectile is more destructive than any that I have ever seen.

296. Supposing that a similar projectile could be adapted to the Whitworth gun which would you prefer then?—I prefer the Armstrong.

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297. Would you prefer it as a breech-loader, or for what reason in the gun itself?—I would prefer it, as I said before, because the projectile is more destructive than that of any other gun, and I do not see how such a projectile can be fired from a Whitworth gun.

298. Was the gun with which you practised at Shoeburyness a muzzle or a breech-loader?—Both have been fired.

299. Supposing that difficulty which you have just alluded to were got over, and that the Armstrong projectile could be adapted to the muzzle-loading Whitworth gun, is there anything in the gun itself, which would make you prefer the Armstrong gun to the Whitworth gun?—The Armstrong gun being wrought iron and the Whitworth brass, I consider the Armstrong gun more durable.

300. Is the difference of the metals your only reason?—No; there is the quickness of the twist of the bore in the Whitworth gun, which has a tendency to wear it out, and also in time there will no doubt be a difficulty in getting the shot home in consequence of the bore getting damaged.

301. (*Col. Ormsby.*) In practice with the Whitworth guns that you have seen have you found any difficulty in getting the shot home?—I was not present at the practice, but a case did occur on the 17th of October last.

302. What sized gun was that?—A 12-pounder.

303. Do you know the reason of it?—A little of the brass got burred; it was a brass muzzle-loading gun, that is the only muzzle-loading gun that there is.

304. (*Col. Simmons.*) Did the bore become abraded?—It became burred up.

305. And so the shot could not be passed freely down the bore?—Just so.

306. Did the shot stick in the bore?—Yes.

307. Do you know how they got it out, or was there any difficulty in getting it out?—I do not know in this particular case how it was got out, because I was not present at the practice.

308. (*Commander Singer.*) Have you ever seen the Armstrong projectile so injured by carriage as to interfere with the loading?—I have seen them slightly dented, but by means of a hammer they were made all right.

309. And consequently there was some slight difficulty in getting the shot home?—Such things are generally seen before the shot is put into the bore, and they are easily rectified.

310. That would cause some minutes' delay, would it not?—It may cause a minute's delay, the delay depending upon whether there was another projectile at hand to use.

311. (*Col. Simmons.*) Confining ourselves to field guns, do you find that those projectiles are liable to much injury in packing, and moving, and travelling?—That would depend upon how they were packed, whether they were sent loose or in boxes.

312. What is the usual process, as to packing in a field gun, ammunition waggon, or limber is each shell packed in a box by itself or in a compartment?—It is in a compartment in the limber. I thought the question referred to the transit from one place to another.

313. In that compartment is it free to move or to knock about in bad roads?—I do not think the play is sufficient for it to move about, there is just room to drop it into its place.

314. (*Col. Ormsby.*) Have you seen any which have travelled a good many miles in the limber box over a rough country?—Yes. I forget the distance which they travelled with them, neither can I speak of the roughness of the roads.

315. (*Col. Taylor.*) Are you aware whether, when the experiments were carried on at first with the 18-pounder gun, the gun packed with its ammunition travelled a certain number of miles from Shoeburyness, round the country?—Yes.

316. (*Col. Ormsby.*) Did you see that ammunition when it came into Shoeburyness after its travelling?—Yes.

317. Was it injured?—Not the slightest; it was used for practice.

318. (*Col. Simmons.*) Where do you receive that ammunition from, for practice, at Shoeburyness?—From Woolwich.

319. How is it packed when it arrives at Shoeburyness?—Until recently it has always been packed in boxes containing four shot or shell.

320. How has it been packed more recently?—I believe it is issued now without being packed; we have not received any 12-pounder ammunition this last four or five months.

321. You yourself receive the ammunition, do you not, at Shoeburyness?—Yes.

322. As a matter of fact do you find much of that ammunition or any of it damaged by coming from the factory, when it is delivered into your stores out of the barges?—We never find any of it injured.

323. (*Col. Ormsby.*) Have you never seen any of it that came down all loose as they used to send the old round shot?—Not with the small guns, except in small numbers.

324. Do you think that the 12-pounder gun is inconveniently long for mounting and dismounting?—That is easily obviated by digging a hole.

325. But have you found it inconveniently long?—It would be inconveniently long certainly without a hole being made in the ground for the muzzle to go in.

326. If it was impossible to dig a hole, how would it be?—It could be easily dismounted down the trail.

327. But it would take a longer time, would it not?—The gun being of such a light weight, it would be a very easy matter to dismount with a detachment of men.

328. But would it take a longer time?—No.

329. Do you remember the greatest number of rounds that you have ever seen fired from one individual 12-pounder field gun?—3,173.

330. What was the state of that gun afterwards?—It is now serviceable at Shoeburyness.

331. (*Col. Simmons.*) Have any repairs been executed to that gun?—None whatever.

332. Is the same breech screw there?—Yes; it has not been changed.

333. (*Commander Singer.*) And the same vent piece?—No.

334. (*Col. Simmons.*) Do you know what number of vent pieces have been used in firing those 3,000 rounds?—No.

335. (*Col. Ormsby.*) Have you ever found the vent piece get so hot that the men could not handle it easily?—Yes.

336. How many rounds do you think it takes to heat it to that degree, that you would be obliged to change it?—From 80 to 100 rounds, ordinary practice.

337. With rapid firing?—With rapid firing; as quick as you could fire, I dare say it would be a little less than that.

338. (*Commander Singer.*) Have you ever experienced any inconvenience in rapid firing with a 12-pounder from the copper ring on the vent piece becoming loose?—No. I have known one or two cases occur with the 40-pounder.

339. Has that been sufficient to render the vent piece for the time unserviceable?—The loosening of the vent ring is generally the forerunner of the breaking of the vent piece.

340. (*Col. Simmons.*) You occasionally replace those copper vent rings, do you not?—Yes.

341. If you say that the loosening of the vent ring is the forerunner of the vent piece itself breaking, is it safe to replace the vent ring by a new one?—When that occurs we generally get the vent piece and examine it thoroughly, to see whether it gives any evidence of breaking.

342. (*Col. Ormsby.*) Have you examined many in that manner, and found them defective and discontinued the use of them, and put them on one side as unserviceable before the vent piece has actually come to



pieces?—No; I remember a 40-pounder vent piece breaking the third round after the vent ring became loose.

343. You have stated that you prefer the Armstrong gun with segment shells to having a shell gun in a battery?—Yes.

344. At a short distance we used to fire case shot from a 24-pounder howitzer. Do you think that an Armstrong gun firing segment shells would be as effective at from 300 to 500 yards as a 24-pounder firing case shot, because that was the howitzer which was attached to a 12-pounder battery?—I should think that the Armstrong shell would be equally effective at that distance.

345. (*Col. Taylor.*) How far do you consider the fire of a segment shell destructive against the head of a corps of infantry?—About 3,000 yards, using a concussion fuse only.

346. What time do you consider that it will take to replace the vent ring, of a 12-pounder when it is required; have you any note or memorandum of that process?—No, I have not.

347. (*Commander Singer.*) Do you think that you could train the gunners sufficiently well to enable them to do what is necessary to a 12-pounder without the assistance of a trained mechanic?—Do you mean facing and bouching the gun?

348. Yes, and also replacing it. Have you ever seen a gunner whom you could depend upon to do this without the assistance of a trained mechanic?—I have never seen any gunners who have been a sufficient time at it to do without that assistance; they have simply seen one gun so faced, that is all.

349. (*Col. Taylor.*) What other Armstrong rifled guns besides the 12-pounder have you had any experimental practice with?—With all natures of them.

350. Just mention them?—The 20, 40, 110, the 7-inch howitzer, and the 6-pounder; all Armstrong guns.

351. Have you had any practice with the Whitworth guns?—I have not been present at the practice.

352. With respect to those other heavy guns, you say that you have found no difficulty with the 12-pounders; have you found any difficulty in handling the heavier ordnance that you did not experience in the 12-pounders?—No.

353. Have you found equal accuracy with the heavy guns as you did in the 12-pounders?—Yes.

354. You have fired the different description of fuses, the time and the pillar fuse, have you not?—Yes.

355. In guns of those large calibres have you found the destructive effect of the shell as great in proportion as that of the 12-pounders?—Yes.

356. (*Capt. Freedy.*) Have you ever known the lead to strip off in firing the Armstrong 12-pounder?—A little.

357. Not entirely?—I have not seen one entirely stripped.

358. In 100 rounds how many may you have seen stripped?—I cannot say correctly; I could only speak from memory, and I have not seen a great number of rounds fired to be present at it for these last two years.

359. (*Commander Singer.*) Have you any objection to fire over the heads of your own men on account of the lead stripping?—It would be an objection.

360. (*Capt. Freedy.*) About as far as you could recollect, upon the average in 100 rounds how many shot have you seen stripped?—I have not seen 100 rounds fired consecutively within the last two years; previously to that time the lead was fixed to the shot by different means from those used at present.

361. Have you seen any stripped since this different plan has been adopted to fasten the lead on?—No.

362. (*Col. Simmons.*) In the cases where you have seen the lead stripped from a shot, does the shot proceed in its flight in much the same manner as if the lead had not stripped?—Yes.

363. (*Col. Taylor.*) The external form of the shot

is so little altered by the stripping, that it does not interfere with its right flight?—Just so.

364. (*Commander Singer.*) You stated that you had no difficulty in handling those heavy guns; do you allude entirely to the guns with the lifting vent piece?—Yes.

365. Have you seen any practice with the guns with the side arrangement?—Yes, I have.

366. In fact, you allude to both descriptions of guns?—I only intended my answer to apply to the old pattern—to the screw.

367. With respect to the 110-pounder; have you never found any difficulty in lifting the vent piece from the slot in order to reload?—At times there might be a slight difficulty.

368. Arising from what, do you suppose?—At times it may occur that the tin cup, which is used to prevent the escape of gas, does not act properly, and jams the vent piece.

369. Have you seen that occur?—Yes.

370. When it occurs how do you clear the vent piece?—We have generally done it when it has occurred with the small end of a hand-spike, applied as a lever between the neck of the vent piece and end of the bore.

371. In clearing it, what amount of delay is occasioned?—It may cause some three or four minutes delay each time it happens.

372. Have you found that the projectiles for the heavier description of Armstrong guns are more liable to be injured than the lighter ones by carriage or handling?—They are generally more liable to injury in consequence of being heavier for the men to lift; in moving them about they are liable to drop them.

373. (*Col. Ormsby.*) Would dropping them do them any harm?—It would do them temporary harm if they fell on a large stone or piece of iron.

374. (*Col. Simmons.*) That is to say, they would be temporarily injured so that they could not be put into the gun until they had been set up in some way?—Until the projection has been either hammered or filed off.

375. Is that a long process?—No.

376. (*Commander Singer.*) That depends upon the extent of the injury, does it not?—Yes.

377. Have you ever seen a projectile so injured that you could not render it serviceable by hammering and filing?—No.

378. (*Col. Ormsby.*) With the large description of gun, the 100-pounder or the 110-pounder, have you found the breech-screw become rather bent and get out of order, so that you could not turn it?—I cannot remember any such circumstance having occurred.

379. (*Commander Singer.*) Have you had any practice with the shortened 20-pounder naval gun?—Yes.

380. Do you consider that the amount of recoil is objectionable?—The recoil is certainly very great.

381. Have you seen it used on a field carriage merely?—I have seen a few rounds fired from the top and under carriage.

382. Do you consider the recoil very sharp?—Very sharp indeed.

383. (*Col. Ormsby.*) Can you fire the Armstrong 110-pounder as fast as the old 68-pounder smooth bore?—I should think not quite so fast.

384. (*Col. Taylor.*) Have you no record of that?—No.

385. (*Col. Simmons.*) Have you known any cases in which the vent pieces of the 110-pounders have been damaged in firing, or have blown out?—I have never known one to blow out. I have known many to be injured and broken.

386. When they break, do any of the fragments fly out?—In the case of the steel ones they did.

387. Are the fragments liable to cause injury to the gun detachment; do they fly out with great force?—All that I have seen have flown a great distance.

388. (*Col. Taylor.*) Have you seen the slide or wedged gun fired?—Yes.

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389. What is your opinion of that as regards efficiency and safety?—I think it much superior to the other.

390. Why do you think it superior to the other?—It dispenses with the screw, which is so liable to get damaged.

391. There is no thread of a screw to break?—No; and no projection at the rear of the gun which may be injured.

392. Do you remember any very remarkable experiment that was made with that wedged-closing principle with a broken one?—Yes.

393. Could you describe to the Committee what was done with that?—The mitre or stopper was broken in two by force on purpose.

394. What was done then with it?—The two pieces were placed together in the gun similar to what they would have been if it had not been broken, and the gun was closed and fired in the ordinary way.

395. Do you remember any particular test that was applied to ascertain if there was the smallest escape of gas; do you remember paper being used?—I remember the paper was put there. I was not present at the gun; but I was informed by those who were present at the practice that there was no escape whatever.

396. From your experience of the slide arrangement, would you consider it beneficial to adapt it to all guns, or merely to the heavier descriptions of guns?—To the heavier descriptions of guns.

397. You think that it would be no advantage to fit it to the lighter guns?—No.

398. (*Capt. Preedy.*) What difference of time would there be in replacing the screw and the wedge; which do you consider would be the quickest working, the breech vent piece or the side-loading?—The wedge principle.

399. (*Col. Taylor.*) Is there any other weakness that you are aware of in those heavy guns but the vent piece?—The vent piece is the weakest point.

400. (*Commander Singer.*) Do you think that the vent piece of the heavy guns is weaker than the vent piece of the lighter guns?—Yes.

401. (*Col. Taylor.*) If it could be ascertained that by any process the vent pieces could be made per-

fectly indestructible, would you then regard the gun as perfectly safe?—Yes.

402. You stated just now that you could not mention the time which it took to work one of these 110-pounders exactly?—No, I have no note of that.

403. (*Col. Simmons.*) How are the shot and shells for the 110-pounders packed for delivery to you?—We have received them latterly loose; formerly they were packed in boxes.

404. Since they have been delivered to you loose, do you find many of them injured by handling them and putting them into the barges and pulling them out?—No; very great care is taken by those who unload the barges, and there is every facility at Shoeburyness for keeping them from being injured.

405. Have you ever had any of them left in your charge for any great length of time; have you had any for two years, or three years, or four years, or five years anywhere in store?—I have some that have been about two years and a half in charge.

406. Are you obliged to clean them or to apply any process to them to prevent the shot from rusting or from being injured by the effects of the weather?—They are simply piled out in the air, the same as the smooth-bore shot; the base and head are painted.

407. You repeat that process occasionally, do you not, the same as you used to do with the smooth-bore shot?—Yes.

408. Do you find where the two metals come in contact, any deterioration of either; that is to say, near the point where the lead terminates?—I have seen a few in which the lead is a little detached from the iron.

409. (*Col. Ormsby.*) Do you think that the shot would be affected if that were carried on to a greater extent?—If it goes all over the shot it would cause it to strip when fired.

410. Do you think that it would increase by time, if the shot were a long time in a pile, say, for several years, exposed to the weather?—It is my impression, that in the course of time, those that were made at the first and the lead put on with tin, will become loosened altogether.

411. (*Col. Taylor.*) You have had no practice at all, have you, with the heavy guns of Mr. Whitworth's manufacture?—No.

The witness withdrew.

Serjeant J. Cox.

Serjeant JAMES COX examined.

412. (*Col. Taylor.*) What is your position at Shoeburyness?—That of staff serjeant in the practice part of the experimental department.

413. You assist Captain Alderson, do you not, in all the experiments that are carried on there?—Yes.

414. You have had a great deal of practice at various times with the Armstrong gun?—Yes.

415. Would you just tell the Committee what your general impression of that gun is as regards range, precision, safety, and facility of handling?—I consider the Armstrong gun to be the best gun that ever I handled. It is the best gun, I should say, to take into the field, for its lightness, and being a good gun; there is no fear of its bursting, and it is also safe; and we get a good range out of it, and great accuracy; and the shell is very effective against troops, or anything that it is brought to bear upon.

416. Have you ever found any exception to that. Have you ever found an uncertain gun of that manufacture?—No; never.

417. (*Col. Ormsby.*) How long have you been at Shoeburyness?—Three years altogether; but I have been employed in that department only the last year and nine months.

418. You have been in the practice part during that time?—Yes. I was on the range 12 months previous to that, taking the range of the different guns that were fired.

419. With reference to the 12-pounder field gun, do you think it is quite as easily worked, taking each

gun detachment as the old 9-pounder?—Yes, and more easily, I should say; it is lighter and easier to be brought into action.

420. Do you think it can take up its range as quickly?—Yes.

421. (*Col. Taylor.*) If a batch of troops, who had completed their preliminary drill, were handed over to you, how long would you require to make that detachment efficient to handle the 12-pounder in the field?—I have had men come down at Shoeburyness to the experiments that had never seen an Armstrong gun before, and I have had them detached for firing, and I have put them through their drills before Captain Alderson came down, and I have put them through the loading part, showing them the screwing up, and taking out the vent piece, and they have got on very well with it; and Captain Alderson has put them through it two or three times, and he has been ready to go on with the firing of the gun without any mistake, or any unsteadiness.

422. (*Col. Ormsby.*) Those men were trained gunners before, were they not?—Some had never been to a heavy gun before, others had just learnt the carbine drill.

423. (*Chairman.*) What time did it take?—About half an hour before the Captain came down I put them through it; it was just for the working of the gun for the carrying out of experiments.

424. (*Col. Taylor.*) If I were to send to you at Shoeburyness and say, there are a number of men



who have not been at the gun drill at all, but who have completed their preliminary drills, how long would you require to make those men a thoroughly drilled gun detachment?—I should think a fortnight to three weeks.

425. Do you remember an instance in which, from the dearth of men, you were obliged to take a gun detachment of men previously undrilled at the Armstrong gun with a 100-pounder on the sands?—Yes; on the naval range platform.

426. Do you remember the time that it took to carry out the practice; what was estimated as the time necessary to load and fire that gun?—I recollect that Captain Alderson tested the men and we fired five rounds in somewhere about six minutes and some few seconds.

427. That was when we drove the tin cup through, was it not?—Yes.

428. (*Col. Simmons.*) With what calibred gun was that?—A 110-pounder.

429. (*Major Young.*) At what range were you firing?—We were firing at different angles; at 2°, 3°, 5°, and 10°.

430. (*Col. Simmons.*) Did that include laying the gun upon the target?—It included laying down the range, straight down the line of pegs at a certain elevation.

431. (*Major Young.*) You do not alter the line at all?—The line is altered by the recoil; it has to be traversed a little each time.

432. (*Col. Taylor.*) You have had more to do with the heavy Armstrong guns, I think, than with the 12-pounder?—Yes; chiefly with the 40-pounder and 110-pounder. I have often fired a 12-pounder, but chiefly the heavy ones.

433. Have you seen instances of the vent pieces of those large guns giving?—Yes.

434. To what do you attribute that generally?—In most cases where I have seen them give, it has not proceeded from the service charge. One broke with Mr. Noble with a charge of 25 lbs.

435. What was the service charge?—14 lbs.

436. Have you seen any of the vent pieces blown out since the new shape has been introduced with the projection?—No; never since the projection has been on; the last one I saw blown out (in fact the only one) was a 40-pounder, which was stationed on the brick battery.

437. (*Major Young.*) Do you find that the breech screws often become injured in firing the gun?—No; the threads of the screws in the light guns do, but I attribute that a great deal to the men putting them in after taking them out to clean them. I do not think that it is from the action of the discharge of the gun.

438. (*Commander Singer.*) Have you never seen the thread of the breech screw of a heavy gun start from the bar?—No; I have never seen one do so in the case of a heavy gun. Some of the guns have been down there a long time, and I do not think that one of the breech screws is injured.

439. (*Col. Ormsby.*) Have you seen any of them injured in other ways besides the thread stripping and expanding, so as to make it difficult to get any vent in?—No; I have never seen any difficulty with the breech screw, only when the vent piece is broken, it bulges the end a little after the vent piece splitting, but there is no difficulty in taking it in and out.

440. (*Col. Taylor.*) In the event of a vent piece having broken, you have generally found, have you not, that the face of the breech screw has required repair afterwards?—Yes; it has bulged a little in some instances, and sometimes not.

441. (*Major Young.*) Can those small repairs be generally effected by the military armourer?—Yes.

442. (*Col. Taylor.*) What is your own impression with respect to the advantages or disadvantages of breech-loading. First of all, in the case of field guns. If you were going to be detached with two guns, we will say on service, would you rather have breech or muzzle-loaders?—I should take a breech-loader.

443. What are your reasons for preferring a breech-loader?—Because of the great facility in loading.

444. (*Col. Ormsby.*) Have you any other reason?—It is more safe also. You can load as quickly as you like with the breech-loader; whereas, with a muzzle-loader, you are liable to have a bad No. 2 sponging out, and then there is a danger of one of the numbers being blown from the gun.

445. Have you ever seen that?—I have never seen it, but I have read of instances of it. A case, I think, happened at Dover.

446. (*Col. Taylor.*) Has it ever occurred to you, in comparing a breech-loader with a muzzle-loader, one requires the care and caution of one man, whereas the other requires two men to be cautious and careful. The man who sponges, and the man who serves the vent in the one case, and in the other only the man who loads, is that the case?—Yes.

447. (*Col. Simmons.*) As the weight of the vent piece increases the difficulty of loading, would you consider the facility of loading in a heavy gun greater in a breech-loader than in a muzzle-loader?—No.

447a. Does the previous answer that you gave apply both to heavy guns and to light guns?—No; I referred then to light guns.

448. Which do you prefer in the heavy guns; say a gun of the calibre of a 110-pounder, a breech or a muzzle-loader?—I should prefer the 100-pounder as a breech-loader before any other gun.

449. (*Major Young.*) Do you think that there is more liability to some of the parts getting out of order with a breech-loader than with a muzzle-loader, and the gun being for a time disabled?—A breech-loader is more liable to little injuries, because a muzzle-loader is liable to very little injury; but I should prefer it on account of having such good precision, and being such a good shell. It is the most destructive gun that I have ever seen yet.

450. Have you seen the firing put a stop to for a time, owing to any portion of the breech arrangement getting out of order with a breech-loader?—Nothing further than the vent piece breaking and having to replace it.

451. Have you never found any jamming the shells or anything of that sort?—No.

452. (*Col. Ormsby.*) Have you ever seen the vent itself clogged up, and thereby causing a miss-fire?—No, never.

453. (*Major Young.*) How many rounds do you think you could fire with a 12-pounder before it would require the refacing of the copper?—There are guns at Shoeburyness that have fired 200 rounds with the same vent piece before refacing. I do not mean continual firing.

454. (*Col. Ormsby.*) Have you seen any inconvenience from the vent piece heating in small guns?—I have sometimes.

455. In rapid firing how soon does it get inconveniently hot?—I have seen some get hot in a quarter of an hour, and others not get hot in double the time.

456. At the same rate of firing?—Yes.

457. Are you referring now to the new vent pieces or the old ones?—The old ones.

458. Do the new vent pieces get hot as readily as the old ones?—No, there is a handle to the new ones, and you can lift them in and out as often as you like, and you do not feel the heat of the vent piece.

459. Have you ever seen a 12 or 9-pounder gun or any light field gun disabled from the thread of the screw becoming detached or the breech screw getting out of order in any way?—I have seen the end of the thread become loose in course of time, but when we find that we take a hammer and chisel, and take it off, and the gun is as good afterwards as it was before.

460. Have you never seen a gun disabled from any other injury to the breech screw?—No.

461. (*Col. Taylor.*) Supposing that a process were discovered by which the metal of the vent piece were made indestructible, if you could remove the risk attendant on the vent piece from the heavy Armstrong

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*Sergeant J. Cox.* guns, do you consider that there would be any other objection to them?—No, I cannot see any other objection.

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462. (*Major Young.*) Is there not a possibility of the breech not being properly screwed up without the man who has to screw it up being aware of it by the fact of dirt getting into the thread of the screw?—When it is home, it is solid, and if it is not home you can tell by the feel or sound of the handle.

463. (*Commander Singer.*) Have you ever seen a gun fired without the breech being screwed up?—Yes.

464. (*Col. Simmons.*) What happened?—The vent piece flew out; that was the 40-pounder that I spoke of before.

465. (*Commander Singer.*) That was by carelessness, was it not?—Yes.

466. (*Col. Simmons.*) Did the vent piece go far?—Between 50 and 60 yards.

467. (*Col. Ormsby.*) From the complication of the machinery connected with the breech-loading Armstrong gun do you think that being exposed to the fire of artillery it is more liable to become out of order than the muzzle-loader?—Yes.

468. Supposing you get the same range and the same accuracy with the one as with the other, if you were ordered on service would you take the muzzle or the breech-loader?—If I were going into the field I should certainly take the breech-loader.

469. Notwithstanding the liability of the enemy's shot hurting it?—Yes; I should stand the risk of that.

470. Does that apply equally to the larger guns, always supposing, as I said before, that you get the range and the same accuracy and the two guns exactly alike, except the one being a breech-loader and the other a muzzle-loader?—I should prefer the breech-loader, because I have never seen any gun that is so destructive as the Armstrong gun.

471. Assuming that the muzzle-loader is equally as destructive as the breech-loader, and, speaking practically of the working of the gun, which would you prefer?—I should take for the heavy gun a muzzle-loader.

472. Why would not that apply to the field gun?—Because the field gun is much lighter than any other muzzle-loader gun that you could get.

473. Granting all that, but having the two guns the same, the only difference being that one is a breech-loader, and the other a muzzle-loader, which would you take then?—I should take the breech-loader for the light gun and the muzzle-loader for the heavy gun.

474. Why?—It is more easily worked, I consider, as a field gun.

475. What is your reason for preferring the muzzle-loader to the breech-loader in a heavy gun?—For this reason; there is no breech-screw or anything of that kind.

476. Do you think that an objection?—I should think it so, because I consider that it would be more liable to injury.

477. That equally applies to the field gun, does it not?—Yes.

478. (*Col. Taylor.*) If you were in a casemate, and firing a gun in a casemate, would you rather have a breech-loader that you could load at the breech without running the gun back very far, or would you rather load at the muzzle?—I should take the breech-loader in preference to any other gun, if it was in position, but if it was to go into the field I should prefer the muzzle-loader, if it were a gun with the same precision and the same projectile that the Armstrong gun has.

479. (*Col. Simmons.*) I presume that you consider the breech gear of a heavy gun liable to injury from knocking about in the field?—Yes, I consider that it is liable to injury knocking about in the field; and there would be a little difference in getting it into action quicker.

480. (*Col. Ormsby.*) Do you think that you could

get a breech-loader quicker into action?—No, we could get a muzzle-loader quicker into action.

481. (*Commander Singer.*) Have you had much practice with the 110-pounder at high elevations?—Yes, we have practised at 22°.

482. After firing one round with 10° of elevation and proceeding to load again, would you alter the position of the gun before you loaded it?—Yes.

483. Do you find that necessary?—Yes.

484. Therefore there is a loss of time?—Yes.

485. You would not get the projectile home unless you did so?—No.

486. How many men do you generally take to ram home a 100-pounder projectile?—Two.

487. On a wet day, when it is sloppy and wet, would two be quite sufficient?—Yes; we generally put the feet inside the grating when it is wet so as to prevent the slipping.

488. (*Col. Taylor.*) Have you found any difficulty attending the use of the cups in a 110-pounder?—No.

489. (*Col. Ormsby.*) Have you had any experience with the Whitworth guns?—I have.

490. How long ago?—This last summer.

491. What sized guns were they?—We fired the 70-pounder I think last March, and we have fired the 12-pounder since.

492. (*Chairman.*) What metal were they made of?—The field 12-pounders, were brass guns, and the 70-pounder was an iron gun.

493. (*Col. Simmons.*) Is it a coil gun, the same as the Armstrong gun?—No.

494. (*Col. Ormsby.*) Were you one of the numbers at the gun or were you superintending the men?—I was superintending the men.

495. Do you see any difficulty in loading the 70-pounder, for instance?—Yes; I think it was last March that we fired that gun, and there was great difficulty in getting the shot or shell home; two men should ram home, but it took three or four to get it home.

496. How long did you take to load it?—It would not take very long, about half a minute; but it does not go home so rapidly as the smooth bore, or any other muzzle-loading rifled gun.

497. Did you get good practice from it?—Yes, very good practice.

498. Which do you think is the best; the 70-pounder Armstrong or the 70-pounder Whitworth?—I should say the 70-pounder Armstrong was the best, the shell more destructive.

499. Have you fired shot?—We have fired shot; we did not fire the Whitworth 70-pounder at a target but up the range.

500. Do you know what the range of the Whitworth 70-pounder was; was it greater or less than that of the Armstrong 70-pounder?—A little over.

501. (*Major Young.*) Was the accuracy as great?—We did not fire at a target.

502. What should you say, speaking from your own observation?—From observation it seemed to go correct, always to the right of the line a certain distance each time.

503. (*Col. Simmons.*) You stated that there was a difficulty in ramming home the shot or shell of the 70-pounder; was it a very tight fitting shell?—Almost all of them were. I attribute that to the air in the gun; as you force the shot home it tends to come forward again.

504. Then it is not from the friction of the shot on the bore, but from the compressed air in the rear of the shot?—Yes; we often have to ram it, sometimes several times before we get it home; there is not enough windage to let it go home properly.

505. With regard to the 12-pounder Whitworth gun with which you practised at Shoeburyness, did you practise with it as a muzzle-loader or a breech-loader?—A muzzle-loader.

506. Did you find any inconvenience in that gun in passing the shot down the bore in loading?—Yes; the last time we fired, a shell was jammed.



507. How did you extract that shell?—We got a blacksmith's tongs and worked it about and loosened it till we drew it out.

508. Did you examine the bore afterwards?—Yes, it was examined.

509. What was the cause of the shot sticking in the bore?—The gun had blistered.

510. Was it a brass gun?—Yes.

511. (*Col. Taylor.*) Two or three attempts were made to get that shell down, were there not?—Yes, there were.

512. (*Col. Simmons.*) Were many rounds fired from that gun?—We had fired about 12 or 14 rounds that day before that happened.

513. Was the damage repaired immediately?—Yes.

514. Were many rounds fired with it afterwards?—Yes.

515. The same day?—Yes.

516. Did you find any difficulty in loading with the other rounds?—No; during the time of firing this gun the Inspector of Artillery's men happened to be at Shoeburyness examining the guns, and they put it to rights.

517. Were they long about it?—About 20 minutes.

518. Then you proceeded with the firing?—Yes.

519. Had you any difficulty in getting any other shot down afterwards?—Not afterwards.

520. Did the gun fire true?—Yes.

521. Did it give good results on the range?—Yes, very good.

522. (*Col. Ormsby.*) With which could you load the quickest, the 12-pounder Armstrong or the 12-pounder Whitworth, supposing the shot did not stick?—With a smart detachment, I think, I could use the breech-loader quicker than I could the muzzle-loader.

523. (*Col. Simmons.*) Supposing the detachments were equally trained, how would it be?—I think the breech-loader would have the preference, but not a very great deal.

524. (*Maj. Young.*) That is only with reference to the field gun, I suppose?—Yes, only with reference to the field gun.

525. (*Col. Ormsby.*) I think you stated before, that you could load a muzzle-loader heavy gun quicker than you could an Armstrong breech-loader.

526. Which could you load the quickest in the case of a heavy gun, say, a 100-pounder?—If a smooth bore it could be loaded quicker than a breech-loader, as the charge and shot could be rammed home together, and the gun would not have to be depressed. If a muzzle-loading rifle gun, the breech-loader would have the preference, as the charge and shot would have to be rammed home separately.

527. (*Col. Taylor.*) You are aware that a projectile, which is coated with lead in that way, could not be loaded from the muzzle?—No; it could not.

528. You have been present at all the practice at the iron plates?—Yes.

529. Which do you consider the most destructive gun that you have seen yet against iron plates; which is the rifled gun which has penetrated the thickest plates?—The Whitworth has penetrated the most; with special shot I have never seen it fired against plates with the ordinary cast-iron shot.

530. Which gun of Mr. Whitworth's was that?—The 120-pounder.

531. Have you seen the shots with which those effects were produced?—Yes.

532. Are you aware what they are made of?—Of homogeneous metal.

533. (*Col. Ormsby.*) From what you have seen in practice with heavy Whitworth guns and Armstrong guns, firing against iron plates, which gun would you take if you had to fire against a ship plated with iron?—For firing against an armour-plated ship I should take Mr. Whitworth's gun in preference, with special projectiles.

534. That is a muzzle-loader, is it not?—Yes.

535. (*Chairman.*) For what reason would you give it the preference?—For its greater velocity and greater penetrating power.

536. (*Col. Ormsby.*) Was that gun which produced those effects as easily worked as the Armstrong gun?—I was sick at the time it was fired, so that I was not at the practice.

537. (*Col. Taylor.*) Have you seen any objection to the side-loading system of Sir William Armstrong?—No.

538. You have not seen any difficulty in loading with it, or any accident of any kind that has occurred with it?—Not of any kind whatever.

539. If you were asked the question, would you prefer to man a battery, say of 110-pounders, or 70-pounders, loading in the present manner with the vent piece, or with the side-loaders and wedges?—I should prefer the 70-pounder with the side-loading arrangement to the vent piece.

540. Do you remember the number of rounds that were fired on one day with a 70-pounder side-loader?—50 rounds in 32 minutes and 32 seconds were fired at five and 10 degrees, making good ranges. There was not a target put at the extreme range.

541. (*Col. Simmons.*) Had the gun to be depressed on each loading?—Yes, we had to depress it at 10 degrees on each loading, not at five degrees.

542. Could they pass the shot in without depressing it?—Yes.

543. At what angle is it necessary to begin depressing a gun for loading, say a 70-pounder?—We can manage at five degrees, but at anything more we must depress it.

544. And with a heavy gun, such as a 110-pounder, at what angle do you depress it?—At anything over two degrees we depress.

545. Of those 50 rounds which you fired, were half of them at five degrees and half at 10?—25 at five degrees, and 25 at 10.

546. With one 25 it was necessary to depress, and with the other 25 it was not necessary to depress?—Yes.

547. That makes a great difference in the time necessary for loading, does not it?—Yes.

548. (*Col. Ormsby.*) Have you seen any Armstrong 12-pounder field guns after having been travelled a great number of miles?—No.

549. What is the greatest number of rounds that you have ever seen fired consecutively, firing pretty fast without stopping?—From 70 to 80 in the course of the day.

550. What gun was that out of, a large gun or a small gun?—A 12-pounder.

551. Was there any damage done to the gun; when it was examined afterwards was it in perfect order, or had anything given way?—Nothing whatever; it was in perfect order.

552. (*Commander Singer.*) Have you had much experience in projectiles getting injured and causing difficulty in loading?—None whatever.

553. In the case of field projectiles for a 12-pounder gun, have you ever seen the lead so injured that you could not load the gun?—Never.

554. Have you never seen that happen with a heavier gun?—I have seen a 110-pounder shot bruised at the bottom sometimes, which caused us to get a hammer and tap it down; nothing further.

555. (*Col. Taylor.*) You have not seen it injured to such an extent as to stop your practice?—No.

556. (*Col. Simmons.*) Have you ever had occasion to reject the shot altogether and take others?—Never.

557. Could you always tap them up on the ground?—Yes; sometimes a man has happened to drop a shot and buried it up a little, and before we ram it home we take a hammer and tap it down level, and it is just as good as ever.

558. (*Col. Ormsby.*) In the Whitworth guns, have you seen solid shot fired as well as shells?—Yes.

559. Do you think they are as good for the one as for the other; do you think they are quite as capable

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*Serjeant J. Cox.* to fire shells as to fire solid shot?—No; I do not consider the shell that is made for the Whitworth gun good.

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560. What do you object to in it?—I think that from the manner in which the shell is made it is impossible to cause the shells to have effect; there is a weak and a strong point in it; at the angles it is too strong, and in the flat of the rifling it is too weak, so that the shell cannot be made to have the same effect, and cannot be built up inside the same as the Armstrong shell.

561. You think it would not burst properly?—I have seen several that have been brought in, which have not burst at all, the fuse has been just blown out.

562. Was that because there was not a sufficient bursting charge?—It might be that there was very little bursting charge put in.

563. If the bursting charge was increased, would that evil be remedied, or do you think it is the fault of the construction of the shell?—I think it is the fault of the construction.

564. (*Col. Simmons.*) In practice with the 12-pounder Armstrong field gun, do you find that the grooves foul at all?—No.

565. Have you to clean them out at all in the course of practice?—Never.

566. (*Col. Ormsby.*) Have you ever seen the 12-pounder Whitworth and Armstrong guns, or either one or both, dragged through water or mud, or anything of that sort, and then fired immediately after?—No; I never have.

567. (*Col. Taylor.*) Have you had practice with the shunt gun?—Yes.

568. What is your opinion of the shunt mode of loading; have you seen good practice with it?—Yes, very good practice with the 70-pounder.

569. (*Commander Sizer.*) Have you seen as good practice as with the ordinary breech-loading 70-pounder?—Yes, equally as good.

570. And as long a range?—Yes.

571. With respect to the shunt 12-pounder, have you seen any practice with it?—No, I have not seen any with that gun.

572. (*Col. Simmons.*) Is the shunt 70-pounder as easily loaded as the breech-loading 70-pounder?—Yes.

573. Do you think you could serve the one gun as rapidly as the other?—No; I think I could load the side breech-loading gun faster than the muzzle-loading guns.

574. The shunt loader you must sponge, must you not?—Yes.

575. Were you at Shoeburyness in the habit of practising the Armstrong guns before those lubricating wads were adopted?—Yes.

576. Were the bores liable to foul then?—More so than they are now. First there was water used, and then there was a wad made of grease and sawdust, previous to this one which is in use now.

577. Were you obliged to use the water very frequently?—We used to use the water at first every round.

578. (*Col. Ormsby.*) There was no occasion for using it so frequently, was there?—No; about every 10 rounds I should think would be quite sufficient.

The witness withdrew.

Captain HENRY JAMES ALDERSON examined.

*Captain J. Alderson.*

579. (*Col. Taylor.*) What is your position?—I am Assistant Superintendent of Experiments at Shoeburyness.

580. What has been your experience with respect to the precision of the Armstrong field gun?—It is extremely precise.

581. At all ranges?—Yes, at all ranges.

582. Have you met with any exceptions to this; that is to say, any guns that have been exceptional and irregular in their action?—Not any guns in particular, but with some shot in the early days of the gun, when the lead was not properly fixed on, the lead used to strip sometimes, and then the shot did not go as regularly as they ought to have done; but that is completely remedied now.

583. Have you never found any inequality in the construction of the guns; have they always been of the same character?—Two guns will not always shoot exactly the same, but they will shoot very regular; for instance, one gun will require 5' or 10' perhaps of elevation more than another, but that gun will always require it.

584. From the experience which you have had what are your views with respect to breech-loading as compared with muzzle-loading for field guns?—If I could get as good a muzzle-loader as the Armstrong gun, I should prefer a muzzle-loader to a breech-loader for field purposes.

585. (*Col. Ormsby.*) Will you state your reasons why?—Chiefly on account of its simplicity.

586. (*Col. Taylor.*) If you were offered the command of a battery, supposing the two guns to be equally effective in every way, you would prefer to take the muzzle-loading gun?—I should prefer to take the muzzle-loading gun, provided it was as good as the present Armstrong gun.

587. As this Armstrong gun is in the service, what do you consider its chief weaknesses?—In the breech arrangement, I consider that the vent piece is the weakest point. That is the part which has hitherto been the weak point; the part which has generally gone. I do not attribute any harm to an inch or so of

the thread of the breech-screw coming off. That is very easily repaired, and does not at all damage the gun; but a bad vent piece will sometimes disable a gun for a few minutes.

588. (*Major Young.*) What do you think is the reason of the breech-screw becoming injured; is it from the breech not being properly screwed up?—I think it is from a defect in the manufacture of the thread of the screw; from flaws, that is what I have noticed principally.

589. (*Col. Ormsby.*) Have you found that the thread of the screw always goes at the same place; at one end more than the other?—Yes, generally speaking it does.

590. At the outer end?—At the end towards the vent piece, that end being more liable to injury in replacing the breech-screw after cleaning.

591. (*Major Young.*) It is for that reason that I asked the question, thinking that it might be caused by a blow, or the breech not being fully screwed up?—No; I think the accident occurs from flaws or carelessness on the part of the men.

592. (*Col. Taylor.*) Do you consider that the weakness of the vent piece involves any actual danger to life or injury to the gun detachment?—I have seen many vent pieces, both experimentally and otherwise, blown out or broken, and we have never had an accident.

593. Have you ever seen one blown out since the new form of vent piece has been adopted?—No.

594. Then if the element of uncertainty could be got rid of in the vent piece, you would not see any objection to that system of loading?—No; it is as good as any breech-loading system that I know of.

595. (*Col. Ormsby.*) Do you prefer it to the muzzle-loading system?—If I could get the same range, the same effect, and the same accuracy and lightness, I would prefer the muzzle-loader.

596. (*Major Young.*) Why cannot the side-loading or wedge principle be adopted for field guns?—I do not like it for this reason; when you have got the wedge piece and the stopper out, they are far more liable to receive any passing injury from shot, or any-



thing like that, and if so, I do not think you could remedy the injury at once; the stopper might get bent from flying bullets, or dirt, or anything of that sort, and there is nothing like that which could occur in the screw breech, because the two screws are closed to all external damage; and if the vent piece is lost, you have always got spare ones; but if one of those wedge pieces got damaged in the gun, you would find some little difficulty in removing it. I have never seen it in any lighter gun than a 40-pounder.

597. (*Col. Taylor.*) In the 70-pounder heavy guns, do you think that the side stopping is a good arrangement?—Yes. I have not seen much practice with it. I have not seen many rounds.

598. (*Col. Simmons.*) You spoke of the breech-screws being in the habit of stripping; do you expect that to be the case with all screws after a certain number of rounds, or is it an accidental circumstance from a bad screw?—It is very hard to say how it occurs, because our guns are constantly in fresh hands, and the screws are always being taken in and out to be cleaned about every fortnight or three weeks by fresh men and they are dropped and knocked about; and it is a wonder to me that they have not been more knocked about than they are. It would be different in a regular battery, where you have only certain men, who always take charge of the same guns. They do strip about six, or seven, or eight inches, and I have seen as much as a foot of the screw taken off; but it does not appear to injure the gun in any way; the broken bit is easily taken off.

599. Do you find that they are old screws which strip; that is to say, screws which have been much used?—I cannot say for certain, but I think so.

600. Are they more liable to strip, after being used for any length of time, than when they are first put in?—I think so.

601. (*Commander Singer.*) Have you ever had an instance of the thread springing from the body of the screw in the centre, or near the end of the thread?—I do not remember at this moment, any instance of the thread springing in the centre.

602. Have you ever known a screw rendered completely unserviceable by the thread stripping?—It is very hard to say what would be unserviceable; we have had one breech-screw in particular that stripped; but there we noticed that it was very full of flaws; it was an old gun, and it went little by little, and I think we got it down to as little as four or five threads perhaps, but I am not speaking with certainty. We got another instead of it, but we fired it still in that way; when we had it first, we noticed a number of flaws in it.

603. (*Col. Simmons.*) It is always the male screw which gets damaged, is it not?—I have noticed the end of the female screw coming off, but that was only in one or two instances.

604. (*Col. Ormsby.*) Do you think that the breech-loading 12-pounder Armstrong gun is as effective for case shot at short ranges as the old 24-pounder howitzer?—Yes, I think so at 300 yards, certainly, because I should always in firing a case shot use the concussion fuze and not the time fuze; but perhaps if you got up to within 100 yards and had to put the time fuze at zero it would not be quite as good.

605. If you were fitting out for service a field battery of say six guns, and you had your choice of guns, what sort of guns would you take; would you take six Armstrong guns?—I would take four 12-pounders and two short 20-pounders.

606. Are those short 20-pounders good shot guns as well as shell guns?—Very good shot guns.

607. (*Col. Simmons.*) At long ranges?—At field ranges up to 3,000 yards.

608. To shoot a 20-pound shot?—Yes, a 20-pound shot.

609. (*Col. Ormsby.*) What is the weight of the gun?—The gun weighs about 12 cwt. 1 quarter.

610. (*Major Young.*) Do you remember what charge of powder a common shell contains?—It is one pound.

611. (*Commander Singer.*) Do you consider the recoil of the short 20-pounder inconvenient?—I have never seen it yet on a proper carriage for field purposes; we have only had it on the low carriage which we call a naval carriage, but I have myself mounted it upon a 32-pounder howitzer carriage, and I have fired a great many rounds from it, although that was not the proper carriage for it. I had to rig it up in a temporary manner and it answered very well indeed, and I did not get an excessive recoil.

612. (*Col. Simmons.*) Provided that the carriage is not liable to injury from recoil in field artillery, you do not object much to the recoil?—Not at all.

613. (*Col. Ormsby.*) Have you had any experience of the Whitworth guns?—A little.

614. Both of field guns and large guns?—Yes.

615. Which should you prefer as a field gun?—The 12-pounder Armstrong gun, for this reason, because I consider that any injury to the bore of the 12-pounder Whitworth would disable that gun completely.

616. (*Major Young.*) Are you now alluding to the brass gun or the homogeneous gun?—I am alluding to the brass 12-pounder; supposing a shell burst in that gun, I believe that the gun would be rendered unserviceable.

617. (*Col. Simmons.*) Would not that apply to any muzzle-loader; for instance, take the shunt gun; if a shell bursts within that, would not it be liable to injure the bore in the same way?—I do not think that it would necessarily do so.

618. (*Col. Ormsby.*) Would it not injure the bore of a 12-pounder breech-loading Armstrong gun?—It does not injure the firing, because the lead gives way if it comes to any obstruction; nearly all our guns down at Shoeburyness have had shells burst in them.

619. Have you not seen a Whitworth gun disabled from the effects of a shell?—I have seen one, but I am not prepared to say what the actual origin of the injury was, for I could not trace it. It happened in firing for Colonel Boxer, who was carrying on the preliminary practice; the day before we were firing shell, and had a shell burst near the gun; I saw that it either burst in the bore or at the muzzle; we went on with the loading, and we had no difficulty in loading that day. The next day, at the fourth round, I think it was, speaking from memory, the shell jammed about eighteen inches down the bore, and we could not get it down one way or the other, and I had great difficulty in getting it out. I sent for a pair of long tongs which we had in one of the shops, and I got them round the head of the fuse, and after a great deal of tugging I managed to get the shell out. I put a searcher down, and I felt a certain distance that there was a burr in the bore. At that time the inspector of artillery had some men down at Shoeburyness examining the guns, and I sent for one of them; he examined the gun and found a burr in it. I wanted to finish the experiments that day, so we got an old pattern 12-pounder shell, and we found that by screwing a rod into it we could push it down past this obstruction with a little difficulty, and then we put some sand and water into the bore, and rubbed the shell up and down till we removed this burr.

620. (*Col. Simmons.*) That was a brass gun?—Yes, it was a brass gun.

621. Do you think that if the gun had been made on the coil principle, the same as an Armstrong gun, it would have been liable to receive the same injury?—I have never seen one, therefore I cannot say.

622. That might have been an accident, due to the soft nature of the brass metal?—Yes.

623. (*Col. Ormsby.*) Do you think that it equalled the Armstrong gun in point of accuracy of range?—Yes.

624. And facility of working?—Yes.

625. And rapidity of firing?—I have never seen a Whitworth 12-pounder brass muzzle-loader pitted against a breech-loading Armstrong gun for rapidity of firing. The breech-loading Whitworth, and the

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breech-loading Armstrong I have seen fired against one another for rapidity.

626. (*Col. Simmons.*) What is the calibre of the two guns, the Whitworth 12-pounder, and the Armstrong 12-pounder?—Of the Whitworth 12-pounder, I think the major axis is three inches, and the smaller axis 2.75 inches; in the Armstrong gun it is three inches, very nearly the same calibre.

627. A good deal has been said about the destructive power of the Armstrong projectiles, that is to say, the built up segmental shot or shell; could you state to the Committee the effect of those shells, as to the dispersion of the fragments when the shell has exploded, and the fragments are set free, as to the extent of ground which is covered by them, or rather the spread of the burst?—If you were firing and burst a shell about 20 or 30 yards from a column, you would get a spread of about 20 or 30 yards on the face of the column, but we have never done anything to determine that. I am only speaking from guess, because the utmost extent of targets which I have ever seen fired at has been 27 feet. I allude of course to the mass of the shell, which would have the most destructive effect, not to outlying pieces, many of which would fly from 40 to 50 yards.

628. Have there been no experiments at Shoeburyness expressly to determine that point, as to the destructive power of those shells when fired against a column of infantry?—Not to determine the extreme spread.

629. Have you any experiments on record to determine at what distance in front of a line or column of infantry, it would be desirable to burst one of those shells with a view to produce its greatest destructive effect?—We have plenty of experiments to see the effect on targets, that is all.

630. (*Col. Ormsby.*) In firing the Armstrong shell have you found that all the segments separate?—We did not at first.

631. Do they now?—Yes, they do now; at first there was perhaps rather too small a bursting charge.

632. (*Chairman.*) The bursting charge has been increased, has it not?—Yes.

633. (*Col. Ormsby.*) Have you had any experience at Shoeburyness of pivot guns for sea service?—We have had a great number of guns to fire there of different calibres, which I believe were afterwards used as naval guns.

634. (*Commander Singer.*) Do you not find the land service 12-pounder objectionable for a field battery?—I think with advantage it might be shortened a little bit, and it would be easier to handle.

635. Do you think the sea service 12-pounder a better adapted or a handier gun?—I think you lose a little in range by reducing the length, but I do not think you lose much; perhaps a little shorter gun would be a handier gun.

636. (*Col. Ormsby.*) Have you seen any field battery after it has been travelled a great deal on rough roads?—No.

637. (*Major Young.*) Have you found any difficulty in loading from the projectiles altering their shape?—Yes, sometimes, if they have been dropped on end there would be a burr formed; but the man whose business it is to issue the shell ought to see that it does not come up in that shape; and it is easily remedied by a hammer. I allude to a heavy shell. I do not think that a 12-pounder would alter at all unless it were dropped on iron or stone.

638. Could that be rectified on the spot?—Yes, at once; it is always done by a hammer; and I make it the man's business who looks after the shell to see that they came up in proper order, and there is no difficulty at all; a tap of the hammer puts it all right.

639. (*Col. Simmons.*) Is there any peculiarity in the recoil of the Armstrong gun?—It is a very sharp recoil.

640. Does the gun jump at all?—Yes, there is a good deal of jump in it.

641. It is more than it used to be in the old smooth bore?—Yes.

642. Do you find the same effect in the case of the Whitworth gun?—The carriages are different; the 12-pounder brass Whitworth has a fixed elevating screw, and the Armstrong has a moveable one.

643. In fact the two guns have not been compared under the same circumstances?—No, not in that way.

644. (*Chairman.*) Have you never been on service with those Armstrong guns?—Never.

645. (*Commander Singer.*) You stated, did you not, that for heavy guns you prefer the muzzle to the breech-loader?—Not for every purpose; for siege guns I prefer the breech-loader 40-pounder; of course there are exceptional circumstances where perhaps the breech-loader is preferable; in casemates and places like that it would be handier.

646. You would not go so far as to say that you prefer the muzzle-loader for heavy guns?—I would not say that generally. I think there are cases in which the breech-loader comes in very handy.

647. Do you consider that the shunt 120-pounder gun is an efficient gun?—Very much so, from what I have seen of it; we only had one, which was merely an experimental gun; it never was in the service.

648. (*Col. Ormsby.*) Do you think that it is more severe upon the men working with the 110-pounder gun than with the 68-pounder?—Yes; I think perhaps it is for two or three of the numbers; it is not so heavy a gun as the other to run up; but, taking it on the whole, I think it is a heavier gun to work; it would use up two or three of the men, and would tire them out sooner.

649. In changing rounds you think that there would not be much difficulty?—There is not much difference in working of a 110-pounder and a 68-pounder, except in the handling of the sponges; they have all got to run up the gun; it is heavy work for two of the men, certainly.

650. Have you seen the breech-screw become unserviceable in heavy guns, either from its expanding or getting bent?—I have seen it damaged from the vent piece breaking. The old steel vent pieces used to fly, and that would act against the end of the breech-screw and burr it in, and you would not be able to send the next shot home; there would be a burr in the inside which would have to be filed down, and the face of the breech-screw made true again.

651. Would there be any difficulty in getting the breech-screw out?—No, it is easy enough to get it out; it is in the inside of the shot passage that the burr is, and it turns over the edge.

652. (*Commander Singer.*) Do you find the heavy guns often strip and not take the rifling?—If they are not run up properly they would do so.

653. Do you find in ordinary practice with an ordinary gun detachment that such a thing as that would happen frequently?—No, not if ordinary care is taken to see that the gun is properly loaded.

654. You never find the chamber foul so as to prevent the projectile getting home to its seat, and thus causing it to strip?—Not with the Boxer lubricating wad.

655. (*Major Young.*) Have you any objection to the shunt gun principle of construction as regards the manner of loading and the way the shot leaves the bore, and so on?—From what I have seen of it as yet it seems to answer, but I have not seen enough to give any opinion upon it.

656. (*Commander Singer.*) Have you experienced much difficulty in the vent-piece of the 110-pounder jamming after the rounds so as to prevent its being lifted up?—In some instances, but there is no difficulty in removing it. I have been always in the habit of having a short crowbar about three quarters of an inch in diameter at the side of the gun, and No. 2 puts it in in front of the vent piece, presses it back, and removes it at once. It occurs if the vent piece is too small, and the tin cup jams in, or the vent piece is too high and there is a burr in the bouch.

657. You look upon that as an objection, do you not?—Yes, but it is easily remedied, there is no difficulty about it.



658. (*Major Young.*) Have you made any experiments with the new time fuse, and the new concussion fuse?—There have been some experiments made.

659. Do you think that the objections which arose after keeping the old fuses for some time would be likely to arise with regard to those fuses?—I think not. So far as I can see I think that that objection is remedied in the present form of fuse; but I cannot speak with any degree of certainty upon that point.

660. (*Col. Taylor.*) The last experiments which were carried out with the new pattern time fuse were successful, were they not?—Very successful indeed. I think that the great thing in their favour is that you can make them more or less sensitive as you wish, and can fire with reduced charges or full charges, both with the concussion fuse and the time fuse. The ordinary E time fuse can be made to answer for the full charge or the half charge without any difficulty, you shear off two of the wings, and that is done by pushing in a little rod at the escape hole.

661. (*Chairman.*) Have you tested their liability to deteriorate by immersion in salt water?—They have never been regularly kept in water; they have been dipped in water, and taken out at once. We have done that with concussion fuses, and they have answered just as well after having been for an hour, because they are hermetically sealed by the varnish.

662. (*Col. Ormsby.*) From the practice that you have seen at Shoeburyness if you were to fire against an armour-plated ship what gun would you take if you had your choice?—I have not seen one yet that is big enough to do any real harm to her; I think that nothing under a 300 or 600-pounder would do any harm to her.

663. Do you think that the Armstrong and the Whitworth guns that you have seen tried against those plates are equally good guns?—The Whitworth gun has beaten the Armstrong gun, because the Whitworth has penetrated where the Armstrong has not; but I should not think that the effect of a small bursting charge inside a ship, would at all disable that ship.

664. If you were obliged to arm a battery with either the Whitworth or the Armstrong gun for that purpose, which would you take?—The only one that has penetrated the iron plates as yet has been the Whitworth 120-pounder; the Armstrong has not done it. As yet the Whitworth has been the only gun that has done it, but I should prefer to have a bigger. I do not like any of the present guns; none of them are big enough according to my idea.

665. You prefer at the present moment the Whitworth to the Armstrong gun?—I do at the present moment. I have not tried the Armstrong heavy guns with an identically similar shell, so that I cannot say whether they would do it or not. Mr. Whitworth's 120-pounder gun is the only one that has fired that peculiar shell; but from what I have seen I have no reason to doubt that any other gun, with a shell of the same material, would do the same thing.

666. (*Major Young.*) You consider it merely a question of the material of the shot?—Just so.

667. (*Col. Simmons.*) Have you made any experiments at Shoeburyness with the guns as to penetration into masonry or earthwork?—Yes; there have been some experiments but not many with masonry.

668. With what guns have those experiments been made?—With all sorts of guns. There have been experiments made at Eastbourne, by the Ordnance Select Committee.

669. (*Major Young.*) Do you conceive that the projectiles penetrate straight through, or that they turn round?—They turn round, that is to say if you fire them as shot.

670. Do you conceive that to be due to the twist of the shot?—To the twist of the shot and the resistance that it meets with as it goes on.

671. (*Col. Simmons.*) Have you any recorded experiments to show the effect of the Armstrong shot as fired against earthworks or masonry?—Only a

few; we had some against masonry, because that was part of the experiment against iron embrasures, and of course many shot did not strike the iron and struck the masonry, and their effect was recorded; some shots struck the brickwork, but they were not considered good on account of the brickwork not being good, so that what I have seen was not satisfactory. As to earthwork all the penetrations that we have had recorded have been in connexion with obtaining initial velocities, in which case we fired into an earth bank, but I think there were only a few rounds from a 20-pounder and 12-pounder.

672. Could you send in to the Committee in a tabular form the records of those few rounds?—They were sent to the Ordnance Select Committee, and they will furnish this Committee with all the information with respect to the penetrations.

673. (*Chairman.*) Have you had any experiments as to the applicability of guns employed to throw shells with molten iron?—Yes; we have had some experiments with a 40-pounder and a 100-pounder Armstrong.

674. Are they serviceable?—Yes, we have had no difficulty.

675. (*Col. Ormsby.*) Those shells are cast shells that are filled with molten iron, are they not?—Yes, we filled them ourselves on the spot; they are made in rather a peculiar form and lined with non-conducting material.

676. They are not built-up shells?—No, they are common shells.

677. (*Commander Singer.*) They do not appear to crack their lead coating with the heat?—We do not leave them long enough; five or six minutes is the time to leave a molten iron shell after firing, and we keep the men splashing a little cold water over the lead.

678. In fact an elongated projectile with molten iron is as efficient as a spherical one?—Yes, so far as the molten iron goes it is as effective, but I do not consider that it is worth anything.

679. (*Col. Simmons.*) Have you made any recorded experiments with the Armstrong guns in ricochet firing?—Yes, we have made some that are recorded.

680. Is it an effective shell when fired for ricochet practice?—If I could get a concussion fuse or a fuse to go off with a very small charge of powder I think it would be the most effective shell that could possibly be used; you get a fall with a high angle and a low velocity, the shell has a very steep descending angle, and it is wonderfully accurate.

681. That is rather as a plunging fire than a ricochet fire?—I would not attempt a ricochet fire; I should always use a plunging fire.

682. For ricochet purposes you do not recommend the use of an elongated shell?—No.

683. (*Major Young.*) Would not the ordinary fuse do for that?—No, because each fuse requires a certain shock to shear the wings. We have tried a fuse that will go off with a 1.5 lb. charge, 5 lbs. being the service charge for a 40-pounder, but it will not act with less.

684. Are those concussion fuses arranged for that?—They will not go off with less than that; you want to have one that would go off with about 14 oz.

685. Cannot that be done with shearing a portion of it off with a tool?—You can only shear off two wings; that would make it sensitive enough to go off with 1.5 lb., but in its present construction you cannot do any more than that, because it would go off of itself. You must not make it too sensitive, because in running it home it would explode. It is quite easy to make a fuse for that purpose, but there is not one at present in existence.

686. (*Col. Simmons.*) Have you had any experience as to the fitness of the 12-pounder Armstrong projectile to stand carriage in limber or ammunition waggons?—No. Under the old rifle cannon Committee I believe the original 18-pounder Armstrong gun and some ammunition travelled over 500 miles.

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687. Can you tell what state it was in after it had travelled that distance?—No.

688. (*Col. Taylor.*) Do you consider the present carriage of the 12-pounder Armstrong gun strong enough for the service?—The converted ones seem to break from the firing; what we have seen down at Shoeburyness break across by the elevating screw.

689. (*Col. Ormsby.*) With regard to muzzle-loading and breech-loading guns, do I understand you rightly to say that if you can get range and accuracy you would prefer a muzzle-loader to a breech-loader, except in certain positions, such as firing in casemates?—I do not think I went quite so far as that.

690. Will you explain as clearly as you can which you prefer of the modes of loading?—I think that for field purposes the muzzle-loader would be the simplest and easiest; for siege purposes, such as 40-pounders and those sort of guns, I prefer the breech-loader. A 40-pounder screw gun I consider an admirable gun for siege purposes; you get rid of the long rammer and the long sponge; it is very simple, and from what I have seen it does not seem liable to get out of order, and when you come to heavier guns and guns in garrisons and casemates and other places, I have no doubt that breech-loaders would be the best suited. But I think for ordinary purposes I would sooner have muzzle-loaders, because it would require less care, and be less difficult to look after them, and for general purposes.

691. (*Col. Simmons.*) The defect of a muzzle-loader, which is due to the liability of the shot jamming in passing down the bore, is not such an objection as to make you prefer the breech-loader?—That is only inherent in certain modes of rifling.

692. Does the preference which you give apply to some particular muzzle-loader?—No, not exactly that; if I could get a gun, for instance, like the Armstrong 12-pounder, there is no harm done to it if a shell bursts in the gun; and if I could get a muzzle-loader in which a shell bursting in the bore would make no difficulty in the loading, then I say, I should prefer a muzzle-loader to a breech-loader; but if you injure the bore so that you cannot load, of course you throw the muzzle-loader *hors de combat* at once.

693. Sir William Armstrong in his evidence stated that he preferred the breech-loader because of the liability which there was in muzzle-loaders to the shot becoming obstructed by some foreign substance, such as sand, or anything else, and so getting jammed in the bore, in which case it becomes a difficult matter to extract the shot; and on that account he stated to the Committee that he himself would prefer a breech-loader, although he was ready to submit a muzzle-loader to the consideration of the Committee. You do not consider, do you, that the liability of the shot to jam, is such an objection to the muzzle-loader as to make you prefer a breech-loader to a muzzle-loader?—Of course, the only two guns that I speak of are the Whitworth muzzle-loader and the Armstrong breech-loader. My objection to the Whitworth muzzle-loader was, that a shell bursting in the gun would damage the bore, and being a tightish fitting shot, I think the bore would be very liable to get injured, so that you could not load, and that would immediately throw that gun *hors de combat*, and I prefer the Armstrong breech-loader to the Whitworth muzzle-loader because there is not that liability.

694. (*Major Young.*) I think there is some little misapprehension about the Whitworth gun, because in his evidence, Mr. Whitworth did not say that he proposed distinctly that the metal should be brass?—I am alluding to the Whitworth brass 12-pounder muzzle-loader.

695. (*Col. Simmons.*) I am supposing that it is jammed by sand or some foreign substance?—If you sponge it out, I do not think it ought to jam; a wet sponge ought to be able to clean the gun out, or a dry sponge ought to do it.

696. (*Col. Ormsby.*) Have you ever seen those field guns of Sir William Armstrong's or Mr. Whitworth's dragged through ditches, and get into a great mess

inside?—Yes; I have seen that the case with Armstrong guns.

697. Have you then seen them cleaned out and fired?—Yes.

698. In what time?—That was done by one of the officers who was down with his battery, Major Goodenough, and I never saw a gun in such a mess as this Armstrong gun was. They had dragged it through the mud, and could not get it out again very easily; the bank slipped, and the gun went bodily down into the slime, and when it was got out the bore was completely filled, and you could not see whether the vent piece was there or not. It was one slimy mass of mud, and everything was closed up; but one could unscrew the breech at once, and take the vent piece out, and then by putting the finger just round the slot, and throwing the mud away, the slot was cleared completely, and a sponge passed along the bore, cleaned the bore completely, and the gun was then ready for service.

699. How long was it from the time it was upset before it was fit to fire?—They fired blank cartridge from it, and cleaned the gun completely, I think, in five minutes, but the gun could have been fired in about two minutes from the time they got it up; they took five minutes, because they cleaned it and washed it, but there was no necessity for taking up so much time.

700. Do you think that a muzzle-loader could have been made ready so rapidly?—Perhaps not. If they had a large supply of water, they would have required to wash out the bore of the muzzle-loader, and in that case I should have required to load it with a blank round, to clean the muzzle-loader out.

701. (*Col. Simmons.*) In the course of your experience with a 12-pounder, or with any of the Armstrong guns, have you found that the bores become damaged at all from shells bursting in them, and in what way, do they show that damage; are the grooves cut?—The grooves are burred over.

702. That is not sufficient to stop the firing, is it?—No; and it does not seem to damage the precision at all.

703. (*Commander Singer.*) Have you seen any practice with the Armstrong shortened projectile, a calibre and a half long?—Yes, we fired some, and the Iron plate Committee fired some.

704. For ricochet, have you seen whether that was better than the long shot?—There was some practice one day, but I was not present; it was fired for initial velocity.

705. (*Col. Taylor.*) You have seen experimental practice, have you not, with Mr. Whitworth's gun?—Yes.

706. Is the range of Mr. Whitworth's gun greater or less than that of Sir William Armstrong's?—Greater; it has a quarter of a pound more charge.

707. With similar charges is there any difference?—They are very nearly the same; the brass muzzle-loader, and the 12-pounder with similar charges, would be very nearly the same; the breech-loader would have a longer range; it is a much longer gun.

708. Are you aware that the comparative parallelograms of error of the two guns were?—At this moment I could not say, but it is in the report which went up to the Ordnance Select Committee.

709. (*Chairman.*) These are the words of the recommendation to this Committee, "As a great number of experiments have been made of late years with the guns and projectiles proposed by Sir William Armstrong and by Mr. Whitworth, the Committee should examine the officers who have conducted them, as well as those who have had experience of the use of any of the guns brought under their notice." Did you conduct the experiments?—Yes, I carried them out, and I could hand in the reports which were made on the subject of the experiments. (*The witness delivered in the same.*)

710. (*Col. Taylor.*) With the latest pattern of fuses and segment shells, have you found little or no error in the action of the fuses with the shrapnell shells?—They are very good indeed.



711. Do you consider the segment shell fired from the field gun as it now exists a very formidable weapon?—It is the most formidable shell that I know of.

712. Do you consider that there ought to be with the Armstrong batteries in the field a certain proportion of solid shot?—Certainly, for particular purposes.

713. Do you recognize the want of a shell gun, and a shell containing an efficient bursting charge, in the field, according to the present system?—Certainly; I think there is a great want in that respect.

714. What would you suggest to supply that want?—A 20-pounder, what is called a boat gun.

715. What is the bursting charge of that shell?—1 lb.

716. Do you remember the number of segments in the 110-pounder segment shell?—111 large ones.

717. The bursting charge of the common shell is 8 lbs., is it not?—Yes, 8 lbs. for the 110-pounder.

718. Is there any other gun shell that you know containing a similar bursting charge, or rather, what is the heaviest bursting charge of the smooth bore?—The 10-inch shell is 5 lbs., the 68-pounder is 2 lbs. 4 oz., and the 8-inch is 2 lbs. 4 oz.

719. You have seen some practice, have you not, with the pillar fuses?—Yes.

720. What is your opinion of the pillar fuse for the purpose for which it is intended, namely, for acting against a ship?—Against a wooden ship it is a very admirable fuse, it has a certainty in going off, and my impression is, that it will go off whether it hits sideways or point foremost. From what I have seen, I believe it will go off if it strikes sideways, so that if the shell grazes the water first and ricochets against the side of the ship the fuse will go off; that is my idea of it from what I have seen.

721. Do you not consider that in the fact that the coil system almost invariably gives notice of its deterioration, there is an element of very great confidence and security?—Yes, certainly; you know then when a gun is going. We have had several instances of that; the guns have commenced to go, and have given us warning; I am alluding to certain experimental guns which were fired with very excessive charges, and we saw when they were beginning to go.

722. (*Chairman.*) What was the nature of the warning?—Their beginning to open in the coils.

The witness withdrew.

Adjourned to to-morrow at 11 o'clock.

## Tuesday, 13th January 1863.

PRESENT :

MAJOR-GENERAL RUMLEY, Inspector-General of Infantry.  
COLONEL ORMSBY, R.A.  
COLONEL TAYLOR, R.A., Commandant of School of Gunnery.  
CAPTAIN PREEDY, C.B., R.N.

COLONEL SIMMONS, C.B., R.E.  
COMMANDER SINGER, R.N.  
MAJOR YOUNG, R.A., Director of Artillery Studies.  
WILLIAM POLE, Esq., F.R.S.

CAPTAIN DYER, R.A., Assistant Inspector of Artillery, Secretary.

MAJOR-GENERAL RANDAL RUMLEY IN THE CHAIR.

Major GEORGE ALDERSON MILMAN examined.

723. (*Col. Taylor.*) What position do you hold?—That of Captain Instructor of the School of Gunnery.

724. You have had in your capacity of Instructor of the School of Gunnery a great deal of practice with all kinds of guns, have you not?—Yes.

725. What description of gun in the service should you say is the one which has given the greatest range of those that have been performed with, the rifled gun or the smooth-bore gun?—The rifled gun.

726. Do you consider that you are able to get with the rifled gun now in the service as long a range as you would ever require on service?—Certainly.

727. And do you consider the action of that gun honest and uniform under all circumstances?—Quite sufficiently uniform for all possible purposes to which it might be applied.

728. What is the longest range at which you are in the habit of firing at ordinary instructional practice with the squads under your charge?—3,000 yards is the extreme limit for ordinary purposes.

729. And at that distance within what front do you consider that a good artilleryman ought to be able to give nearly the whole of his fire with shot?—50 yards.

730. Supposing that his first shot showed an error of, we will say, three or four yards deflection, would he not by a simple rule be able to correct it for the next round, so as to attain much greater accuracy?—Certainly.

731. And do you not consider that power of correcting an error by a simple and uniform rule of enormous value to the artillery in the field?—Yes, I certainly do consider it of great value, as to over or

under is a different question; it is very different in that respect to estimate the error; but with regard to right or left you can make very accurate corrections.

732. At a range of 3,000 yards, what amount of accuracy do you think, in rough terms, the most correct eye can attain as to range?—Certainly not under 200 yards, without having somebody out at the flank to guide you.

733. On a plain or on the sea at 3,000 yards, you could not tell within 200 yards where your shot struck?—No.

734. Have you seen any practice with Mr. Whitworth's gun?—I have never carried on the practice myself with it. I have been present at the practice.

735. Are you aware of the comparative range of Mr. Whitworth's gun as compared with Sir William Armstrong's, which gets the longer range?—I could tell it by referring to my book; but I think that the Whitworth has slightly the advantage.

736. With regard to the practice that you have seen with Mr. Whitworth's gun, what should you say with respect to the accuracy of it as a true carrying gun?—The accuracy is very great.

737. (*Col. Ormsby.*) All that you have been speaking of now, as to the great accuracy of range and so on, has been with regard to Sir William Armstrong's gun?—Yes.

738. Not with Mr. Whitworth's?—No, entirely with the Armstrong gun. I have seen a little practice with the field guns; but it has generally been the heavy practice with the iron plates that I have witnessed.

739. What sort of guns were those of Mr. Whitworth's, were they brass or iron?—Brass field guns.

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13 Jan. 1863.

Major  
G. A. Milman.  
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740. Were they the old 12-pounder blocks, which were rifled on Mr. Whitworth's plan?—No; one was a breech-loader, made on his own plan; the muzzle-loaders were brass field guns.

741. The muzzle-loader was only Mr. Whitworth's so far as it was rifled by him?—Just so.

742. And with that gun as compared with Sir William Armstrong's 12-pounder gun, were the range and accuracy as good as Sir William's?—I should think they were; but I am of opinion that the accuracy of both of them is quite sufficient for all possible practical purposes; it does not matter whether one gun goes two or three feet nearer than another, but their accuracy is sufficient for all practical purposes; there is a superabundance in fact; of course it is an advantage to have one gun more accurate than another.

743. (*Commander Singer.*) Do those remarks as to range refer to every description of Armstrong gun?—Yes, perfectly so.

744. (*Col. Taylor.*) Are you aware of the comparative initial velocities of the Whitworth and Armstrong guns?—Yes.

745. Can you give me the mean initial velocities of the two?—I find by my note book that the initial velocity of the 12-pounder Armstrong is 1,242 feet in a second, and of the heavier gun it is 1,166 feet in a second; of the 70-pounder Whitworth I have it 1,184 feet per second with shell, and 1,062 feet with shot. I have only notes which were taken for my own information. I do not quite vouch for the accuracy of them, but that is what I compute them to be.

746. (*Col. Simmons.*) What were the charges in each case?—The regular service charge in the 70-pounder Whitworth, 9 lbs. of powder, and in the Armstrong with shell, the charge was 12 lbs. of powder; in the 12-pounder it was the usual service charge of 1·8 lb.

747. (*Major Young.*) Was the charge the same with the Whitworth and the Armstrong 12-pounder?—They do not fire with the same charge;  $1\frac{3}{4}$  lb. is the Whitworth charge; it was the same weight of shot, a 12-pounder.

748. (*Col. Simmons.*) Have you the initial velocities of the 12-pounder Whitworth as well?—I do not think that I have the initial velocities of the 12-pounder Whitworth, only of the 70-pounder.

749. (*Col. Taylor.*) Are you aware which projectile, the Whitworth or the Armstrong, suffers the most retardation in its flight?—I am not prepared to state that; the one being rifled with so much greater twist than the other; the velocity of rotation is so very different between the shots.

750. The initial velocities being very nearly identical, would you not assume that that which obtains the greatest range must necessarily experience the least retardation?—That certainly would be apparent on the face of things, one would reason so, but I do not think that there is a difference of above 100 yards or so in a range of a distance of 2,000 or 3,000 yards.

751. What is the retardation of the rifled shot as compared with the smooth bore?—Comparatively speaking it is very much less of course.

752. Do you happen to know the data that were ascertained with respect to the comparative retardation of the 68-pounder shot and the Armstrong 110-pounder shot at a target?—I do not think I could state that accurately.

753. (*Mr. Pole.*) The difference in the retardation depends very much, does it not, upon the form of the head of the projectile?—No doubt.

754. The velocities which are most to be depended upon have been obtained under the direction of the Ordnance Select Committee?—Yes, by Mr. Noble, some of the velocities which I mentioned were given from his results.

755. (*Col. Taylor.*) Can you give the Committee any rough but certain facts illustrating the accuracy which you yourself have seen attained by the Armstrong gun?—I could state the average as a general

rule with squads of men, and I could state the average number of shots into a certain space at two or three experiments; the average number of shots that would strike a target with the men laying the gun themselves.

756. What could be attained by a careful and thoroughly instructed man correcting his shot by the simple rules which are furnished, taking the six foot target for instance at 1,000 yards?—The ordinary way of carrying on practice with a squad is at 1,000 yards, 1,200 yards, 1,500 yards and a few shots at intermediate distances up to the limit of 3,000 yards with a target.

757. Out of 20 rounds how many times should you say that a thoroughly competent gunner would hit a 6-foot target at 1,000 yards?—He would hit it on the average with 14 or 15 shots out of 20.

758. Where you present on the occasion of my trying the new range of the Ordnance Select Committee at five targets?—Yes.

759. Could you give the Committee an idea of the closeness of the results?—I think at 400 or 500 yards two or three of the shots went through the same hole out of 5 rounds, three rounds at each target.

760. Could you correct me if I were to err in my account of it?—Yes, I think I could.

761. The facts as I noted them at the time were that at 100 yards two shots went through one hole and one within two inches of it. At 200 yards three shots went through the same hole. At 300 yards two went through the same hole, and one about four inches from it. At 400 yards the three shots made one hole. At 500 yards the three shots were in the same vertical plane with the distance of five inches between their respective centres. Is that correct?—Yes.

762. You have seen a good deal of practice and have yourself conducted a good deal of practice at the iron plates with those guns?—Yes.

763. Do you think that you could by any means attain greater certainty and greater accuracy than you have found?—I do not see that it is requisite in any way.

764. Have you not found the accuracy of the rifled gun as you have used it meet every requirement?—Certainly I have found it so.

765. (*Mr. Pole.*) So that the limit of accuracy depends more on the personality, if I may so speak, of the person firing, than on the capability of the gun?—I think the gun affords much greater facility even to a recruit: after a few days of instruction he would be able to lay the rifled gun with very much greater facility than any other gun.

766. Do you think that the rifled gun has arrived at such perfection that inaccuracy is rather due to the person firing than to the gun itself?—Certainly.

767. (*Col. Ormsby.*) What description of guns are those that you have been speaking of, are they Sir William Armstrong's or Mr. Whitworth's?—Sir William Armstrong's.

768. And would the same remark apply to Mr. Whitworth's?—Certainly.

769. You do not find any difference?—I do not see any as to the accuracy.

770. Do you include the large guns as well as the small?—Yes; it is just the same with the large guns as with the small.

771. (*Col. Simmons.*) Did I rightly understand you to say that with a 12-pounder Armstrong gun and an ordinary gun detachment you should expect to put 15 shots out of 20 into a 6-foot target at 1,000 yards?—I should, with a well-trained detachment; with an ordinary detachment I should say about 12. We use 8-foot targets, and sometimes we put in the whole 20 shots. When it is ordinary firing with batteries, about 10 to 12, but with skilled men we very often put in 18 or 19 out of 20 in the 8-foot target.

772. Does that apply to previously measured distances or merely to judged distances?—The guns are brought up in front of the target, and the distance is known within a few yards; the targets are generally put out at fixed spots; you fire a trial shot and estimate how far it goes over or under.



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773. Practically, this accuracy is obtained at what you may call measured distances?—Yes.

774. Not as artillery would be fired in the field?—No; but after two or three shots you would attain your range with the rifled gun. You may waste two or three shots but you ought not to do more than that at a moderate range; certainly not at 1,000 yards.

775. (*Capt. Preedy.*) Do you consider the accuracy of the Armstrong and Whitworth gun everything that can be desired in real service?—Certainly.

776. The same remark applies to both?—Yes; there is an amount of accuracy, that is quite enough for all practical purposes.

777. (*Col. Taylor.*) Are you in a position to give any very decided evidence as to penetration?—No.

778. Have you not had to carry out any experiments in that direction?—No, nothing more than firing at iron plates, and I could not give that very accurately.

779. You have had nothing to do with penetration?—Nothing beyond having witnessed experiments.

780. With respect to the next point to which the attention of the Committee is called, namely, the ease of working, do you consider that the guns now in the service, the field guns and the heavy guns, are easy to work. Take the field guns first?—Yes, I consider the 12-pounder very easy to work.

781. You do not find any difficulty or any great stupidity to contend with among the squads that pass through?—No, not at all; on the average a recruit is in the habit of going to practice, after six days drill, four hours a day.

782. Supposing a number of average recruits were handed over to you after their preliminary drill, how long should you say it would be before they would be a competent gun detachment for a 12-pounder Armstrong gun with safety in the field, putting No. 1 out of the question?—In five days they would be perfectly efficient.

783. Among those that have been under your instruction you have found some, have you not, who never could acquire the eye to lay a gun?—Certainly.

784. Are those cases frequent?—No, not frequent at all, but that applies to any description of sight; it does not matter what sight it is.

785. Generally speaking, you would say that the use of the tangent sight, with the mode of instruction and the rules which are given, are attainable by a man of moderate intelligence?—Yes, mechanically, very readily indeed. I do not mean to say that they would understand the principles of it, but they would understand the mere mechanical use of it with regard to laying the gun and giving the proper degree of elevation and deflection.

786. Taking the average of squads, have you found among them a sufficient number of intelligent men, especially among the rank of non-commissioned officers to ensure the efficiency of a battery if placed in charge of this gun in the service?—Yes; but my answer must be restricted to field guns. I do not apply it to all the natures of guns.

787. Now with respect to the heavier guns, to the 40-pounder and the 110-pounder, do you consider that they are cumbersome and unmanageable for garrison purposes or not?—No; I like the 20-pounder and the 40-pounder guns very much indeed, but I do not think that the same recommendation applies to the 110-pounder.

788. What is your objection to the 110-pounder?—I think it is more complicated, and when firing at high angles, above a certain angle, you are obliged to depress the gun before loading, and I consider that to be a drawback.

789. In what way is it objectionable to have to depress the gun?—It makes it longer to load and causes a loss of time; and also the men are in the habit very often of forgetting it; it is very hard to impress it upon their memory; they do not seem to consider it as a regular part of their duty.

790. I think it forms a legitimate part of the question of the easy working, how far in the 110-pounder

you consider the present mode of using the vent piece objectionable or otherwise?—I consider it objectionable; none but tolerably tall strong men are able to manage it efficiently; that is to say, with the present mode of loading the 110-pounder with the vent piece.

791. Have you ever found an instance of two men being unequal to the handling of that vent piece; have you ever been obliged to relieve men from incapacity for that?—I have among the officers. I do not think I have among the men.

792. (*Col. Simmons.*) For what reason have they been obliged to be relieved?—From insufficient strength.

793. What is the weight of the vent piece of a 110-pounder?—133 lbs.

794. (*Col. Taylor.*) On the traversing dwarf platform and casemate platform, have you found the compressors answer their purpose well or not?—Yes, they are of considerable service, and answer their purpose very well.

795. Do you consider the number of men now told off to a 110-pounder adequate to work it?—Yes, certainly; we do not use tackle; when we have the naval slide of course we have four men additional, but our ordinary detachments are one non-commissioned officer and nine men.

796. (*Col. Simmons.*) Does your opinion as to the ease of working with regard to the 110-pounder apply to a gun loaded from the side or from the top or equally to both?—No; I think that the wedge system would admit of easier working.

797. (*Col. Ormsby.*) In your answer to a former question in which you stated that in five days a detachment would be fit to work the gun, that applied to a 12-pounder, did it not?—Yes. I referred merely to the mechanical operation of loading and firing.

798. How much longer would it take with regard to the 110-pounder and the 40-pounder?—A longer period with a 110-pounder but not with a 40-pounder.

799. Taking men from their preliminary drill, they not having been put to any other gun, how long would you take to train them?—In about nine days; that is if they had never seen the Armstrong gun before; if they have gone regularly through beginning with the 12-pounder, that of course facilitates the matter very much.

800. You think it is more laborious with those heavy guns?—Yes, decidedly.

801. Do you think that the breech-loading heavy guns are more laborious than the muzzle-loading guns?—Certainly with the vent piece.

802. How long do you think it would take an ordinary No. 1 to be quite efficient at his work in laying the gun and all his duties?—I do not think that with an intelligent No. 1 it would take much longer, not more than another day, inasmuch as he would acquire the other in a shorter time, and in learning the gun exercise the laying goes on just at the same time as the drill, and I do not think he would take longer than the others; but of course that is only with one description of gun; on an average he takes about three weeks with the three.

803. (*Col. Simmons.*) With a gun detachment so drilled in five days for a field gun, would you have any apprehension as to the vent piece occasionally not being put home into its position?—No; I am not speaking of a man who might be nervous on service, or anything of that kind, that is a different question altogether.

804. (*Commander Singer.*) If I understand you rightly you state that the 110-pounder is decidedly heavier in working than the corresponding smooth-bore gun, the 68-pounder?—It is a heavier working gun as regards the vent piece.

805. And the loading?—Not as regards the mechanical operation of loading and putting the shot in; but if you include the vent piece with the loading it is.

806. (*Col. Taylor.*) You have been employed in handling the Whitworth guns, have you not upon occasions?—No; not actually myself. I have only seen them loaded and fired.



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807. So far as regards the ease of working of your guns, you have been speaking only of the Armstrong gun?—Just so.

808. (*Commander Singer.*) Have you fired the muzzle-loading Armstrong?—Yes, I have fired the muzzle-loading Armstrong a good many times—the shunt gun,—but I have given no evidence with regard to that.

809. (*Mr. Pole.*) Those guns that you have been speaking of are guns actually in service?—Yes, they are in the service, all of them.

810. (*Col. Taylor.*) Have you worked the shunt gun at all recently?—Yes, against iron plates at 200 yards.

811. Have you found any difficulty in using that gun?—No, none.

812. Have you seen any instance of the shot sticking?—No, none.

813. (*Col. Ormsby.*) With regard to range, accuracy, and ease of working, the answers that you have given to the questions are applicable to the Armstrong breech-loader, are they applicable also to the shunt gun?—No, only in this way; I have practised very often with the shunt gun, but it has only been at 200 yards with iron plates. I cannot speak as to the accuracy of range, but I can state that the accuracy at that distance was very great.

814. Is the ease of working very great?—There is greater ease in working the shunt gun than the 110-pounder breech-loader.

815. (*Major Young.*) The shot is heavier too is it not?—They were experimental shot and their average weight was 120 lbs.

816. (*Col. Taylor.*) You found no difficulty in working them?—No, none.

817. (*Major Young.*) Were they very regular?—Very regular; you could hit what you aimed at at 200 yards, but I have never had any experience except at that range. I fired it a great many times at that range.

818. (*Col. Simmons.*) Have you had any experience with the 12-pounder shunt gun on Sir William Armstrong's plan?—No; it is not made yet.

819. (*Colonel Taylor.*) With respect to the rapidity of fire, have you any notes that you could refer to, or anything that you could speak to from memory as illustrative of the rapidity of fire with effect?—With regard to the 12-pounder, I have been in practice with every squad that have passed through the instruction, both officers and men, firing a certain number, say five rounds, two or three times against time, and I could state the average number of minutes and seconds that this took; five rounds took upon the average about 3 minutes and 40 to 50 seconds.

820. (*Commander Singer.*) Laying at the same target or a different target?—Sometimes the same and sometimes at different targets. The margin was up to about four minutes, depending very much of course on the numbers one altogether. Sometimes it would take five minutes, but the average was under four minutes in five rounds.

821. (*Major Young.*) Do you find it an advantage to make use of the traversing arrangement?—It is a decided advantage to all the guns, because if anything happens to your traversing arrangement you still have your trail to lay with just the same, and if your traversing arrangement jams you are still in the same position as you would be with the ordinary field gun.

822. You do not find that by traversing with that arrangement beyond a certain angle, it is likely to injure the carriage, or that it does so?—No; they merely use it for the final adjustment of the gun; we are particularly careful to impress upon the men that they have the trail to use.

823. (*Col. Taylor.*) Have you any reliable data as to the 110-pounder?—Not reliable.

824. But with all the detachments going through, in what time have you been able to fire five rounds?—About a round a minute, under four minutes with the 12-pounder, and rather more than a minute a round for the 40-pounder, but with a well-trained

detachment you could fire a 40-pounder under a round a minute; the 100-pounder takes longer.

825. (*Mr. Pole.*) Do you know what influence the breech or muzzle loading has on the rapidity of the firing, taking for example the shunt gun as compared with a similar gun, a breech-loader?—I could speak as to the 68 pounder. I do not think that it has ever been tried with the shunt gun. The one has never been tried against the other. But, as I stated before, they have to depress the gun, and of course that has a material effect upon the quickness of the firing because another operation has to be performed.

826. That with the shunt gun is not necessary, I believe?—No, nor with any muzzle-loader. That is applicable when you get beyond 2°; when you are firing at 1° you do not require to depress the gun before loading; it is only when the muzzle of the gun is pointing up that the men have to ram up-hill.

827. (*Col. Ormsby.*) Do you think that you could fire more rapidly with the muzzle-loader than with the breech-loader in the larger descriptions of rifled guns?—That depends upon the facility of loading, and whether you can put the cartridge in with the shot and ram them home together.

828. (*Major Young.*) Do not you find that the tin cups which are used with the 110-pounder sometimes jam and cause a decrease in the rapidity of fire?—I have known the vent piece to jam; it is very seldom that the tin cup does, but the tin cup is a drawback with regard to the rapidity of fire no doubt.

829. (*Mr. Pole.*) Would the side-loading arrangement for large guns be preferable to having a vent at the top?—Certainly; but you would have the same thing with the breech-loader in that respect with regard to ramming the shell well home.

830. (*Major Young.*) You would still have the same disadvantage with the tin cup?—Yes; but I do not think that the tin cup is very much of a disadvantage; it does not often stick in the bore; it is rather a disadvantage, but not in practice in that way. The combination of the heavy vent piece and the tin cup in the 110-pounder is a drawback.

831. (*Capt. Preedy.*) If the 110-pounder and the 70-pounder were depressed, would it be necessary to lay the gun horizontal to load it?—No; the more you depress it the better, the weight of the shell takes it home.

832. (*Col. Taylor.*) Do you consider that any object is attained in a military point of view by having one kind of projectile only in your limber boxes for field guns?—Yes, certainly, it is a great advantage.

833. In what way?—From its simplicity.

834. Do you consider that the projectile which is in use with the service 12-pounder Armstrong gun meets all the requirements of the field service in its different characters?—Leaving out of the question the rifled howitzers, the 12-pounder Armstrong, as compared with the 9-pounder smooth-bored gun for round shot and shrapnel, I like very much indeed.

835. It meets all requirements as a gun?—Yes.

836. Do you consider that there are circumstances in war, in which the want of these batteries would be felt under the present arrangement?—Unless some proper arrangement is made with regard to firing case shot, I think there would be some confusion.

837. If you were in a position to require case shot what would you do with the Armstrong gun?—There is nothing laid down. I do not practice it, but the system which I have shown to the officers has always been this, and it is laid down by the regulations, that two rounds are kept ready for firing in the axletree box opposite to where No. 1 stands, and there is no danger in having the fuze fixed, and therefore if he has the fuze set at zero all that he would have to do if he were charged by cavalry would be to put that shell into the gun and load at once.

838. When that shell was fired where would you expect it to burst?—From 70 to 100 yards from the muzzle of the gun.



839. Do you consider that the effect of that shell fired at a column coming up would be greater or less than a round of case fired from a 9-pounder?—The effect would be greater provided the shell burst properly, which it would with a proper fuse, but the fuse must be already fixed in the shell because the men being excited, when charged by cavalry, they would have no time to fix it; the fuse must be fixed ready to put into the gun; I have carried on experiments, against the 9-pounder firing case in that way.

840. Supposing the fuse to be fixed with the shell at zero and the shell put in you think that it is an efficient and formidable case shot?—Certainly.

841. In the event of your requiring to dislodge troops from a village or from broken ground, brush wood and so on, how would you provide for a shell fire?—You have no more adequate projectile than the 12-pounder field gun against buildings.

842. Do you not consider that a want?—Certainly a great want.

843. How would you propose to remedy that defect?—By introducing the 20-pounder howitzer or a short rifled gun of large bore.

844. Do you consider that there ought to be with every battery a certain proportion of solid shot, or would you be content with the segment shell fired as a shot?—I would be content with a segment shell but I should not be content without a gun carrying a common shell; however, that is a separate question.

845. Would you take the present projectile for every purpose, or would you have a certain proportion of the guns specially with solid shot?—I should prefer the latter, but that is only applicable to the field gun.

846. Do you consider that the fact of having two fuses, the time and the concussion fuse, gives a greater value to the projectile than one would give?—I think it is an advantage having the two fuses.

847. What advantage does that system possess over a single fuse?—It depends upon the way in which you wish to employ your projectile, but if you have the concussion fuse in with the time fuse, then if your time fuse fails in any way still your projectile will explode upon striking any object or striking the ground. If you have the projectile ready with the time and the concussion fuse fixed in it, you wish to fire it as case, all that you have to do is to depress the gun and let the shell strike the ground a few yards, say 40 or 50 yards in front of the muzzle of the gun; that is, supposing the time fuse was fixed for the long range.

848. (*Col. Simmons.*) Have you made any experiments from which the Committee can ascertain the effect of these segment shells against a column of infantry; for instance, can you state the number of fragments that go into a target of given dimensions?—I have not it written down but I think there are some records to be obtained. I have often fired at bits of wood scattered in different places representing skirmishers, but I cannot state the number of fragments into which they explode only that they produce a very great effect no doubt, but there are diagrams of targets which have been fired at with segment shells which I believe could be obtained.

849. (*Chairman.*) Do you consider that the Whitworth gun has the same capacity as the Armstrong gun for firing different kinds of projectiles?—The same projectile will not answer in the same way, you require two different kinds of projectiles. You have not the same projectile for the same nature of gun; you have the shot and the shrapnell shell.

850. (*Major Young.*) I thought Colonel Boxer had introduced the shell?—That is the one I mean; it has partially segments and partially bullets in it.

851. Why will not that answer in the same way for every nature of projectile?—It is not strong enough; I have seen it fired very often.

852. (*Chairman.*) But are you able to state whether the Whitworth gun has the same capacity for firing different kinds of projectiles as the service Armstrong

gun?—That is a question which I am hardly prepared to answer.

853. (*Col. Ormsby.*) In firing the 110-pounder you fire three projectiles do you not; the solid shot, the common shell, and the segment shell?—Yes.

854. That applies equally, does it not, to the 40-pounder and the 20-pounder?—Yes; we can fire every sort from the heavy guns. And you could fire common shell from the 12-pounder but it would not have sufficient capacity; it would not hold sufficient powder and therefore would not be of any value.

855. (*Commander Singer.*) Are the service projectiles for the 20-pounder as a field gun or as a position gun satisfactory?—Yes; you have the solid shot, the common shell, and the segment shell, and I like the projectile very much.

856. And you also think that the service projectiles for the 40-pounder are satisfactory?—Yes; I think that the projectiles of all descriptions are satisfactory for the purposes for which they are intended. When you come to piercing iron plates that is another question altogether.

857. You think that the 40-pounder common shell is a very valuable projectile?—Yes, and the 20-pounder also as a projectile for field purposes; it holds a very considerable charge of powder.

858. With respect to firing molten iron, have you had any experience with the smooth-bore and Armstrong's gun?—Yes, with both.

859. There is no difficulty is there in firing molten iron from the 110-pounder?—Not at all, if you have a tub of water handy, which you would have, as a matter of course. But if you ask me my opinion as to molten iron, I have no opinion of it at all, whether as to smooth-bores or any other bore; it is not of any practical value.

860. Do you happen to know the quantity of molten iron that a 110-pounder shell contains?—I have fired molten iron both from the Armstrong gun and from the smooth-bore; the weight of the shell empty was 74 lbs., and filled 118 lbs.; the average time was five minutes before firing after filling.

861. (*Col. Taylor.*) Have you any data as to the number of rounds that field guns have sustained without injury?—I know of one gun that I have practised with, a 12-pounder, which has fired 3,000 rounds, and it is still in a serviceable state, but I could not state the number of rounds with regard to any other gun.

862. Do you in the course of your instructional duties remember having at any time to return into store guns that have been in use, and have become unserviceable?—I cannot call to mind any instance of that.

863. In general terms should you regard the Armstrong gun as one of greater or less endurance than the old field gun?—I have had so little experience with the old field gun that I could not give a satisfactory answer to that question.

864. With respect to field guns, the charge that you fire with may be called the maximum charge; it is all that the powder chamber is intended to hold in the 12-pounder, is it not?—It could hold a quarter of a pound more very conveniently. With the wad and the priming the charge fills up the space pretty well, but I have fired 2 lb. charges very often.

865. Have you had many instances come under your own notice of a gun during practice requiring repair; or how many rounds do you consider that a gun will stand without the vent piece being refaced?—It varies very much according to the hardness of the copper, but I should say that the mean was 250 rounds before refacing.

866. What should you put as the lowest?—I should say 150 and upwards.

867. Do you think that the evidence of the necessity of refacing the vent piece is such that it is obvious to a man of ordinary intelligence, and that it is not a thing likely to be overlooked?—I do not think that the necessity of refacing is any great practical disadvantage.

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868. Do you think it is a likely thing that it would be overlooked. Does the deterioration of the copper make itself so plain that you could perceive it at once?—To a man of ordinary intelligence I think it would be perceptible.

869. It is not a thing which requires any very great science or skill to appreciate?—No.

870. (*Major Young.*) After how many rounds do you think that the copper ought to be replaced?—It ought to be replaced after 250 rounds; it may require to be faced after 150.

871. (*Col. Simmons.*) Does it require any particularly skilled artizan to reface the copper, or can it be done by the gunners with such tools as they carry with the guns?—It requires that the men should be instructed. What I meant to say was, that there are two artificers with every battery, who are instructed, but I should not leave it alone to those men; I should have other men instructed in the battery, non-commissioned officers, so that in case anything happened to the artificers you might have men to fall back upon.

872. (*Mr. Pole.*) Can the repair be executed on the field?—Yes, in a very short time.

873. (*Col. Simmons.*) What is the time which it would take a tolerably skilful artifice to reface a vent piece?—About an hour, but that is only with regard to refacing it; there are other operations to be performed; the ring requires to be removed after a certain number of rounds; after about 1,000 or 800 rounds.

874. (*Commander Singer.*) You do not consider that having to reface those guns after a certain number of rounds is unobjectionable?—It is no great practical disadvantage, but you require to have men in your battery instructed how to do it.

875. (*Col. Simmons.*) In the field you carry spare vent pieces, do you not?—Yes, a certain number of tools and spare vent pieces.

876. (*Commander Singer.*) That applies, does it not, to all descriptions of Armstrong guns?—Yes.

877. Do you consider that the difficulty of refacing increases with the size of the gun?—No, you require larger tools of course, but I do not think there is any more difficulty.

878. (*Mr. Pole.*) They have not to be put into a lathe?—No.

879. (*Commander Singer.*) Do you consider that the comparative elaborateness of the gun is an objection to it for general field service as compared with the ordinary muzzle-loader?—If I were asked whether I should prefer a muzzle-loading to a breech-loading new gun, I should say if you could combine with the muzzle-loader the advantages that you have with the Armstrong gun, I should prefer the muzzle-loader.

880. If I understand you, you do consider that there is some slight objection to the elaborateness of the breech-loading system?—As a system I do consider that there is some slight objection to it.

881. (*Col. Simmons.*) Does not the facing operation require the use of a great number of tools?—Yes.

882. Do not you consider it a great objection that in case any of those tools are lost the process might become impossible in the field?—Yes; I should say that there is that objection certainly.

883. Would the same facing implements answer for the different calibres of Armstrong guns?—No.

884. So that you are practically obliged to carry into the field different sets of tools for the different calibres of guns?—Yes.

885. (*Col. Ormsby.*) Have you ever found any inconvenience from the gun getting too hot, or the vent piece getting too hot?—I cannot say that I have; because I have always made it a rule in rapid firing to have a spare vent piece, and we do not use the same vent piece right through.

886. (*Col. Simmons.*) What number of spare vent pieces do you consider it necessary for a 12-pounder gun to be supplied with in taking the field?—There is a certain proportion laid down by the regulations for

field batteries. I do not exactly remember the proportion. I think it is three for each gun; one in the gun and one out, and there should be another spare one carried somewhere else.

887. (*Col. Taylor.*) What is your opinion with respect to the endurance of the field carriage which is provided for the present Armstrong gun?—I think it is very apt to go where the screw comes down upon the trail, upon the upper part of the trail.

888. You do not consider it strong enough there?—It is not quite strong enough there.

889. (*Mr. Pole.*) Are the men who do those repairs your own men instructed for the purpose, or must they be skilled mechanics obtained from a special source originally?—No; it is very easy for a man to learn; in a few hours or a day he could learn to face a gun. If I were captain of a battery I should have a certain number instructed besides the artificers who are furnished to me, and then if the artificers were killed, or died from any other cause, I should still have plenty of men to fall back upon; it is a matter which any ordinary man may learn, and not requiring any mechanical skill.

890. (*Commander Singer.*) Does it not require considerable practice before a man can do it satisfactorily?—Not very much practice; he must be properly shown how to do it; and he must be taught two or three times to do it; but in two or three days a man would be quite qualified to face a gun.

891. (*Major Young.*) He ought to be a smith by trade, ought he not?—No; any ordinary man may do it; there are instruments which it is necessary for him to know how to put together, and how to set to work with; but when once that is done it requires only a little common sense. You might have any number of intelligent men trained to face a gun in a couple of days.

892. (*Mr. Pole.*) Is refacing the only kind of repairs of any importance which is likely to be required?—That includes the whole process. After about 600 to 1,000 rounds the ring has to taken off, and a new one to be put in its place.

893. Can that also be done without having fresh workmen?—Yes.

894. (*Col. Simmons.*) Does that remark apply to the ring on the breech piece?—Yes; and there is a ring on the vent piece, too, and the bouching on the gun has to be taken out.

895. How often does that require to be done?—It varies according to the quality of the copper; but during about 800 to 1,000 rounds it will require three or four times to be refaced.

896. Is re-bouching a gun a more difficult operation than putting fresh copper on the vent piece?—Yes; re-bouching consists of taking out the copper ring in the gun and putting a fresh copper in, and taking out the ring of the old vent piece and putting a new one in.

897. Does that require greater skill on the part of the artificer who does it?—It does require more skill.

898. What is the length of the operation?—On the average about two hours.

899. Can it be done in the field without the assistance of forges or anything of that sort?—Yes, we do not require forges; it could not be performed unless the men are previously instructed in it, but after they are instructed it is not a difficult operation.

900. (*Chairman.*) Are the men so instructed now?—There are a certain proportion to every battery who are instructed.

901. (*Col. Simmons.*) Have you had any experience of the durability of those vent pieces as to their liability to break; have you seen many break or fly. I refer to the last new pattern vent piece?—No, I have not seen the new pattern vent piece break in the smaller guns; I have seen them jam in the heavier guns.

902. From what cause?—From firing in the 110-pounder.

903. In what way do they jam; is it in consequence of any defect in the tin cup, or how do they jam?—From the altering of the form of the vent piece.



904. Are they difficult to free when once they have jammed; does it cause much delay in the re-loading of the gun?—I am only speaking with regard to the heavy gun, and in that case it requires to be prized back either with an iron bar or a hand spike.

905. (*Commander Singer.*) Is the jamming of the vent piece of a 110-pounder a frequent occurrence?—I think I have seen it occur six times with the old pattern vent piece.

906. (*Col. Simmons.*) I understood you to say that you had seen the new pattern vent piece likewise jammed in a heavy gun?—I do not know exactly what the new vent piece is.

907. The vent piece has been described to us as having an extra thickness at the back of it, where it fits into the cavity towards the screw, and that the old vent pieces are obsolete?—That is with regard to the smaller guns. I thought that the question referred to the vent piece which is hardened with hot oil.

908. (*Chairman.*) In fact you have not seen any experiments with regard to the new pattern vent piece?—They have almost all of them got projections in them, if that is the pattern to which your question has reference.

909. Then your answer that you have seen it jammed has reference to the latest pattern?—Yes; to the latest pattern served out to us.

910. (*Col. Simmons.*) With regard to the durability of the breech screw, can you give us any information; in the course of your experience have you found any breech screws of Armstrong guns give way?—No; I have never known a gun of any description become unserviceable from anything happening to the breech screw; only from the vent piece being damaged.

911. Have you known a screw strip at all and cause delay in the firing?—I have never witnessed it myself. If a screw becomes damaged you can knock off the threads. That portion of it which gets damaged is at the vent-piece, and if you knocked off half the threads of the screw still the screw would be quite strong enough to hold.

912. (*Commander Singer.*) Are you of opinion that the service vent piece as applied now is weak and likely to give trouble on real service?—Only with a heavy 110-pounder.

913. You think it is still weak with a heavy 110-pounder?—The last pattern that I have seen I decidedly think so with a 14 lb. charge and a solid shot. I make that distinction; I do not think so with a 12 lb. charge and a shell.

914. Do you think that the breech screw is likely to give trouble by the thread stripping from the body of the screw?—No, I do not think that such an accident to the breech screw is material at all; I have never seen a gun become unserviceable from anything happening to the breech screw, only from injury to the vent piece.

915. (*Col. Ormsby.*) Do you think that on service there is anything in the breech-loading system of Sir William Armstrong which would militate against the gun owing to its construction; do you think it is simple enough in its construction to stand all the hard usage of service as compared with a muzzle-loader?—I have never seen it on service, but I have seen it exposed to wet and thrown into a ditch.

916. Will you state your experience from the practice which you have had with it?—I do not think there is sufficient complication in it to be any great drawback on service, that is to say with regard to the field gun.

917. My question has reference to all descriptions of guns with respect to simplicity of construction?—There is a liability in the breech-loader to be struck by the enemy's shot, which is a drawback to all systems of breech-loading.

918. (*Col. Simmons.*) That is not a greater risk, is it, than the risk of a shot striking the muzzle, for with a wrought-iron gun a shot striking the muzzle would burr it up if you had a muzzle-loading gun?—Yes; you have a breech-loading apparatus and the swinging levers which have a chance of being struck

by an enemy's shot or shell; owing to their mode of construction they are more liable to be damaged in that way, if a piece of shell were to break off one of those swinging levers of course the gun would be done for.

919. (*Col. Taylor.*) With respect to the fuses what is your opinion of the time and the concussion fuses as now constructed of the last pattern?—I entertain a favourable opinion of them.

920. Do you think that they are sufficiently uniform in their action to be trusted to on service?—As far as I can judge they are excessively uniform.

921. What was your experience of the former ones?—They were liable to deterioration and also the time fuse was not applicable to heavy guns because they were made of soft metal and were set up and they were liable to injury from that cause and also to deterioration from being kept in store.

922. Can you suggest any reason for the deterioration of those fuses not having developed itself sooner?—I can scarcely answer that question.

923. When you first knew that old pattern fuse you found no fault with it?—No, not with the field-gun.

924. That deterioration has dated from a recent period has it not?—Yes; that is to say with regard to the uniform action of the fuse.

925. (*Major Young.*) What reason have you for supposing that the present fuse will be superior in that respect?—It is made of harder metal—the other was made of soft metal, of pewter I think, and it was easily compressible and also the fuse composition is now better protected from the atmosphere and held tighter in its place by the metal than it was in the old fuse; it is differently constructed.

926. (*Col. Taylor.*) Do you not consider that the last pattern fuse is better protected against contingencies of the weather and alternations of temperature?—Certainly.

927. (*Col. Simmons.*) You have not the experience of time with regard to that fuse have you?—No.

928. I think you stated that the defects in the old fuse were not ascertained when they were first applied but only after some considerable interval of time?—Yes, just so; but by merely looking at the construction of the fuse you could at once tell that the one would be superior to the other with reference to its keeping qualities.

929. (*Col. Taylor.*) What is your opinion of the pillar fuse; do you consider it a sound and efficient fuse, and one to be relied upon for its action?—As far as regards the number of times that I have fired it I should say it has answered its purpose very well.

930. (*Chairman.*) How often have you fired it?—A great many hundred times. I do not speak with reference to its keeping qualities; I merely speak as to its action.

931. (*Capt. Preedy.*) Have you ever known this pillar fuse which you speak of fail at all?—No. I could not speak as to its keeping qualities; but those that I have fired, and I have fired a great many rounds, I have not known to fail for the purpose for which they were intended.

932. (*Commander Singer.*) Then you think the service fuses at present supplied are satisfactory?—Yes, but they have only been recently introduced. I have only fired a certain number of rounds with them. I have fired a great many rounds. The pillar fuses have been in use for some time, and they have always acted very well. As to their keeping qualities, I can only form my opinion from the formation of the fuse, and looking at the construction of them. The present time-fuse, from its being made of hard metal, is applicable to all the different natures of guns, which is a great advantage, as you do not require separate fuses for different guns.

933. Do you look upon the adapter as a great objection?—No. The old fuse was always set up on firing with heavy charges.

934. Do you think that any advantage is gained by making fuses of the same gauge?—I think it would

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be a great advantage to have the fuses all made of the same gauge, for land purposes certainly. It would be a great advantage to have one thread screw of the same gauge both on land and sea.

935. (*Col. Ormsby.*) With regard to segment shells and shot with field guns, have you found in firing shells that occasionally they do not burst, and that the segments stick together?—I have frequently found with the old concussion fuse and the old burster that the shell did not break up, and that was reported constantly; but with the new concussion fuse and the new burster, which holds a considerably larger amount of powder, the shell always breaks up. Very often they used to go only into two or three large pieces.

936. With the new way of covering those shells with zinc, have you ever seen them strip in field guns?

The witness withdrew.

Lieutenant WILLIAM HENRY LIDDELL, R.N., examined.

940. (*Capt. Preedy.*) Where are you serving now?—On board the "Excellent," as first and gunnery lieutenant.

941. How long have you been in that service?—I have been first lieutenant the last two months, but I have been gunnery lieutenant of that ship upwards of four years.

942. Have you witnessed the experiments that have taken place in the "Excellent" during that time?—Nearly the whole of them.

943. (*Chairman.*) What guns have you been practising with?—The whole of the sea service Armstrong guns except the 6-pounder. I have never seen a Whitworth gun fired.

944. (*Commander Singer.*) Are you of opinion that the ranges of the Armstrong guns are in every respect what would be required in active service?—I think that the range of every description of Armstrong gun in the service is quite sufficient for actual service.

945. You think that there is nothing more to be wished for so far as range is concerned?—I cannot imagine anything more to be desired in that respect except lowering the curve a little.

946. (*Commander Singer.*) If there were a gun of a longer range the trajectory would be lower, and consequently that would become an advantage?—Yes; that was my meaning.

947. (*Capt. Preedy.*) Do you consider that the accuracy of the Armstrong gun on actual service is all that could be desired?—I consider that the accuracy of the gun is greater than the accuracy of most men's eyes; that is to say, any man who has good eyesight will make good shooting with that gun, from what I have seen from experiments, and it is all that I could wish for. Our experiments have been limited to the distance of 2,600 yards on account of the range, and at that distance the firing could not have been better.

948. (*Commander Singer.*) Do you remember any instance of particularly excellent firing at any particular ranges?—I took notes out of my notebook yesterday with reference to good firing, and I find there that in firing 20 shots consecutively from a 110-pounder, rapid independent firing (and we had men at the range to notice the difference), the maximum difference in range was 150 yards; that is to say, between where the shortest and the longest shot struck.

949. Was that at the range of 2,600 yards?—Yes. We have been prevented firing from the "Excellent" at smaller elevations, and also at greater elevations, on account of the limited range. If we fire with smaller elevations from the "Excellent" there is a danger of the shot ricocheting on shore. If we fired with higher elevations than are necessary for 2,600 yards, the shot might possibly pitch on shore.

950. (*Commander Singer.*) You have seen practice at 1,000 yards, have you not?—Yes.

951. Have you had any excellent practice with any other description of Armstrong gun?—My greatest

—I am not of opinion that the stripping is any drawback. It is not so bad as the wooden bottoms that were used with the old projectiles with the ordinary smooth-bore field gun.

937. Have you ever seen the covering strip off?—Very seldom.

938. If they did strip, do not you think that that would be an objection against their firing over troops?—No.

939. Would not the stripping kill a man?—No; you would not have them stripping 70 yards in front of the muzzle of the gun. I do not think that the stripping would have any effect beyond 40 or 50 yards. Troops 70 yards in front of the muzzle of the gun would be perfectly safe.

amount of practice at short distances was at the time when I was carrying on the experiments with Captain Coles's cupola shield, when over and over again the flag of the target was shot through at a distance of 800 and 1,000 yards with the 40-pounder Armstrong gun mounted in Captain Coles's cupola shield. Then we had the same accuracy in pointing that is used with the ordnance on shore, the shield acting as a traversing screw for getting on the direction. On board ship we have not that delicate traversing screw.

952. (*Capt. Preedy.*) Would that be a good thing to introduce on board ship?—I do not think it would be advantageous in a ship from her sheering about and other causes; it is only when there is a fixed platform that the traversing screw would be of use.

953. (*Commander Singer.*) Does what you state about the accuracy of the gun being so great apply to every description of Armstrong gun?—Yes, to every description of Armstrong gun that I have seen fired.

954. (*Major Young.*) Have you seen much practice with the Armstrong field guns?—The practice which I have seen on shore was at Shoeburyness three years ago, but we have had a great deal of practice with the field guns on board ship, as many as 2,400 rounds were fired from a 12-pounder gun from the ship at the targets, and when we had it first of all from a battery, or fixed platform, which we had close to the "Excellent," but there were only a comparatively small number of rounds fired from the fixed platform.

955. And the accuracy was all that you could desire?—All that I could desire. I consider it more accurate than the eyes of most men.

956. (*Commander Singer.*) In fact the accuracy could not be appreciated in consequence of that?—Just so, on account of the deficiency in the eyesight of most men.

957. (*Capt. Preedy.*) Was the practice as good from the ship as from the fixed platform?—We found scarcely any difference.

958. I suppose there was little or no motion in the "Excellent"?—Occasionally we found a roll of a couple of degrees each way from the ship being very light and in consequence of the continual exercise that was going on. I have seen even greater difference than that, certainly much more than sufficient to throw out the aim of a gun. Two degrees would be an exceptional case, but at all times there would be more than sufficient to throw out the aim of a gun.

959. (*Col. Taylor.*) Referring to the expression made use of as to the accuracy of the gun exceeding that of most men's eyes, do you not conceive that very extravagantly long ranges are more or less illusory as regards accuracy of practice, that the eye is incapable beyond a certain distance of ascertaining the effect of a shot?—I speak of the action of the shot in many cases from our having sent men up to see how far the shot fell beyond or in front of the target.

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960. If you had been firing at a ship at that distance you would be unable, would you not, unless the ship telegraphed to you, to know where your shot fell, whether it was 100 yards short or 200 yards?—At the distance of 2,600 yards from such an elevation above the water as the poop of a three-decker you can judge certainly within that distance, being at some height above the water.

961. But you could not from the level?—No, certainly not.

962. If you were firing from the beach, you could not?—Most certainly not; but at practice we always use the telescope.

963. But the telescope is very deceitful as to perspective, is it not?—No doubt it is.

964. The shot often appears to be very much nearer to the target than it really is?—Yes, it would do so certainly, unless you had that height above the water which would give you a very great advantage.

965. (*Mr. Pole.*) So that as regards accuracy you consider that you have arrived at as great perfection as the limits of human eyesight and the accidents of wind and so on would allow?—I do.

966. And as regards the gun itself, you could not wish for anything more?—No.

967. (*Col Ormsby.*) Does the 12-pounder gun fire from boats?—We have had practice from boats, but not to so great a degree as from the ship.

968. Was that practice satisfactory?—The motion of the boat is so very rapid if there is a sea that it is very difficult to get any accurate practice at all.

969. What are those guns supposed to supersede?—The 12- and 20- pounders are to supersede the 12- and 24- pounder howitzers.

970. Which should your prefer?—I should prefer the Armstrong gun.

971. As being more accurate in a boat than those other guns?—For several reasons: supposing the whole of the breech-loading apparatus was working properly, there is an advantage in having a breech-loader. It is difficult to load a howitzer or a muzzle-loading gun in the bows of a boat.

972. Do you consider the guns well adapted for pivot guns as to accuracy of range?—Yes, the experience which we have had with the 110-pounder is certainly in their favour as far as accuracy of range is concerned.

973. Have you had any experience with cupolas?—Yes, in firing from the model of the cupola ahead of the "Excellent," and also from Captain Coles's shield. I was there the whole time that the practice was carried on with a 40-pounder 18 months ago.

974. Do you think that that gun is adapted to fire from cupolas?—A breech-loader, if it would answer in all other respects as far as penetration and so on is concerned, is better than any other for firing from cupolas.

975. (*Col. Taylor.*) You are in a position to know what is the general impression and feeling of the men going through instruction in the "Excellent" and of seamen generally, what should you say was the feeling of the service towards the Armstrong gun as to the amount of confidence to be placed in it with respect to accuracy?—There is no doubt about its accuracy; they are all perfectly satisfied as far as its accuracy is concerned.

976. (*Capt. Preedy.*) Have you had any experience of the Armstrong gun as to penetration?—The only experience that I have had with respect to the penetration of the 110-pounder was against Captain Coles' shield compared with a 68-pounder.

977. Would you state the difference of effect at the same range?—I have my notes with the actual depths of the indentations. My opinion at the time was that, if anything, the 68-pounder was a little superior, but they appeared to be as nearly as possible alike.

978. What was the distance at which you fired?—At 200 yards; that distance was chosen to fire against the shield in order to compare it with other

results which had been attained at 200 yards with the 68-pounder.

979. (*Commander Singer.*) With what description of projectile?—A solid shot conoidal head.

980. With what charge?—The charge at that time had not been increased to the full service charge of 14 lbs., it was only fired with 12 lbs.

981. (*Capt. Preedy.*) Is not the charge of the 68-pounder 16 lbs.?—Yes, the charge of the 68-pounder is 16 lbs, but the charge of the 110-pounder first of all was 12 lbs. for all natures of projectiles, and then afterwards it was changed to 14 lbs. for shot.

982. That was a long time ago, was it not?—What I am speaking of was 18 months ago; the 68-pounder charge has always been 16 lbs. On referring to my notes I find that it is very difficult to give you any comparison in this case because so many shot instead of hitting in the line of the diameter of the shield hit one or two plates to the right or left of it.

983. Is there any report of that?—Yes; all the depths of the indentations and the way in which they were struck I tabulated myself after the experiments were over.

984. Have those tables been furnished to the Admiralty?—Yes.

985. Can you mention the date of those experiments?—It was in August 1861, and the report was sent to the Admiralty in September 1861. It was Captain Powell's report who superintended the experiments off Shoeburyness and at Sheerness.

986. (*Chairman.*) What is your opinion with respect to the disadvantages of the Armstrong guns for broadside guns?—The different disadvantages that we have found are these. First, that all the guns at present in use in the service can be primed before the vent piece is screwed up into its place, and consequently the vent piece can be blown out through the top and may do injury, which has happened on three different occasions on board the "Excellent."

987. (*Commander Singer.*) Does that apply to every description of Armstrong breech-loading gun?—Yes, to all.

988. (*Col. Taylor.*) How did that happen, the vent piece was dropped in, was it not?—Yes, but the breech was not screwed up; the hole is in the vent piece and the tube can be put in without the breech screw being touched.

989. But that would be done without order, would it not?—It would be through neglect certainly; that is an element of insecurity in the hurry of action as we have found out even in exercise.

990. (*Col. Simmons.*) It is a neglect which is incidental to the excitement of action?—Yes.

991. (*Capt. Preedy.*) Could that happen to the improved vent piece?—I can only speak of the new gun from just simply seeing it in the Exhibition, and from the description of it; I have not used it.

992. Have you not used the lately introduced and improved vent piece?—No; one can hardly call it introduced yet.

993. (*Col. Taylor.*) What you want is something that would prevent the possibility of the gun being primed before the vent piece is in its place?—Exactly; I may mention that we have had two different plans of constructing a crutch which would not allow the gun to be primed till it is in its place, one is under consideration on board the "Excellent" now.

994. Whose invention is that?—Commander Singer's.

995. (*Chairman.*) Can you mention any other disadvantage in the Armstrong gun?—Another disadvantage is that the vent pieces sometimes crack. In the case of a trial on board the "Trusty" 12 cracked in firing 150 rounds. On board the "Excellent" in firing upwards of 6,000 rounds we have only had four crack altogether and those were 110-pounders, I may mention also that in the pattern gun that we have had in use for now quite a year the

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vent piece is very much stouter, and none of those vent pieces have cracked.

996. (*Col. Simmons.*) In the case of those 12 vent pieces cracked in 150 rounds, how long ago was that?—Nearly 18 months ago, it was at the time of the experiments with Captain Coles's shield.

997. Is that form of vent piece which then cracked now obsolete?—It is not obsolete in the guns for which it was made. There has been some modification inasmuch as in the back of the vent piece a round projection has been placed to prevent in a measure the vent piece being blown out.

998. (*Col. Ormsby.*) Have any of these blown?—No, those that were blown out of the gun had not that projection on.

999. (*Col. Simmons.*) Had any of those that cracked those projections on them?—None in the "Trusty," but all of those 110-pounders in the "Excellent" had projections on.

1000. (*Major Young.*) The vent pieces that you use at present are heavier, are they not, than those that you used in that experiment?—Those in the new pattern guns are very much heavier.

1001. (*Col. Simmons.*) When those vent pieces crack do the fragments fly out so as to cause danger to the crew?—Not a single fragment flew out in any one case, and the gun was not disabled except in one case.

1002. In that case how was it disabled?—In that case it was cracked right through to the rear, and then the leverage from that point forced the sides of the vent piece out against the sides of the slot and prevented it from being pulled out, and it had to be cut away with a cold chisel on both sides before it could be got out.

1003. That would have rendered the gun unserviceable for how long?—For a few minutes, not more; the copper ring in the rear of the chamber on that occasion was injured, but you could have gone on with the copper ring precisely as it was, and then there would have been simply a slight escape of gas.

1004. (*Capt. Preedy.*) As a broadside gun do you consider the Armstrong 70-pounder and 40-pounder as easy to work and train as the smooth bores?—I have had no experience of the 70-pounder; the 40-pounder worked admirably in training and working as a broadside gun.

1005. (*Commander Singer.*) Has it been of frequent occurrence for the shot to pass through without the lead taking the grooves?—It has occurred, with the 110-pounder we have had seven cases of the shot passing through without taking the grooves, out of 550 rounds. In the 40-pounder there has been one such case out of 3,276 rounds.

1006. (*Major Young.*) Do you know how those shots were marked so that you might determine where they were manufactured?—No, I did not take particular notice of that, we knew that it would take place when we fired the shot, because we knew that the shot was not home in its place. If the men do not use the whole weight of their body it does not go home into its place. In the case of the 12-pounder it occurred once in 2,400 rounds.

1007. (*Col. Ormsby.*) That was due to the neglect of the man was it not?—Yes; but he may slip his foot if the deck is greasy or slippery from any cause.

1008. (*Chairman.*) Can you mention any other disadvantage?—Another disadvantage is that in the 110-pounder the tin cup jams, thereby preventing the vent piece from being taken out sometimes.

1009. (*Col. Taylor.*) Is that jamming of the vent piece by the tin cup of frequent occurrence?—In some guns it does not occur at all, in others it is very frequent.

1010. Have you ever ascertained by very accurate measurement, what the comparative play was between the vent piece and the tin cup in those cases?—We have had no instruments to measure that. The tin cup also sometimes instead of remaining in its place in the rear of the chamber, at high elevations, slips and falls out.

1011. You mean that it falls out after firing?—It falls out as the vent piece is dropped in without the men knowing anything about it. That has occurred frequently with us, we only fire at high elevations, at 7°, on board the "Excellent" with a 110-pounder.

1012. (*Capt. Preedy.*) Is it from the cup not fitting properly that it slips out as you describe?—It is from the elevation given to the gun, and as the vent piece is dropped down there is a little jar which causes it to fall out. I may mention that it would not cause the gun to be fired so as to be dangerous to the men at the gun, or to allow a greater escape of gas, because we always use a chalk mark on the breech screw, which would show the man that the breech was not up in its place.

1013. (*Col. Taylor.*) That would delay the firing of the gun, would it not?—Yes.

1014. You could not fire the gun with the cup dropped out in that way?—No; it would cover the place for the primer, and that would cause delay in the firing.

1015. (*Chairman.*) Can you mention any other disadvantage?—We have also found the time fuses act badly.

1016. (*Major Young.*) Are those the old pattern time fuses?—We have had none of the new pattern. Captain Hewlett has made a special report, I think, two or three times that they were acting badly, and he simply received as an answer that the same thing had been discovered also at Shoeburyness, and in fact everywhere else. From the 40-pounder there were 15 per cent. of failures; when I say failures, I mean merely those that had not burst and those that burst prematurely. From the 20-pounder the failures were 16 per cent.

1017. (*Col. Taylor.*) How far back does your record go?—Our record goes back the whole of the time that we have had the Armstrong guns.

1018. Have you found the same as has been found at Shoeburyness, that the deterioration of those fuses has been progressive?—We had scarcely any failures, or a very small per-centage of failures, I think, for the first year that we had them. Lately they have been much greater. Not only have we had these failures, but also the time has not been good, and in fact they are not at all so good as the Boxer fuse of the smooth bore. Then, again, with the time fuse there was danger from the percussion arrangement being in the neck; but that has been got over in the new fuse. If the shell had dropped with the cap of the fuse down its weight might cause the hammer to act, and the fuse to ignite. What called our particular attention to it was that one day, in the "Stork" they were obliged to leave off firing on account of something getting into the range, and one of the men very stupidly attempted to force back the shell to draw it out, and it ignited. Then that having occurred, it was tried by the officers of the ship whether putting the fuse into a shell, and letting it fall on something hard, would set the fuse in action, and it did set the fuse in action.

1019. (*Major Young.*) Did the fuse act when the men were trying to draw the shell out of the gun?—Yes, the fuse acted and blew the man's hand away. That was what called our particular attention to it. It was never dreamt that a man would ever do such a thing as that; it is never considered necessary to give instructions on such a self-evident matter.

1020. (*Col. Simmons.*) Are you aware whether the new pattern fuse is liable to the same accident?—It is not, owing to the hammer being in the body of the fuse. I saw a section of that fuse in the Exhibition, and I know that it is to be the service fuse, but we have not had them sent to us yet. We are using the old fuses. I am sure that the new fuse is safe in that respect, but of course I am mentioning all that we have found wrong. That accident called our attention to the concussion fuse, which we also found to be dangerous, as throwing it violently on the deck caused it to act. That fuse has recently been superseded by



one which I consider perfectly safe. Another fault that we have found is that there has been no means of exploding a shell dropped over a parapet.

1021. (*Col. Taylor.*) What is the greatest angle at which you have ever fired a shell over a parapet?—We have fired at 800 yards.

1022. What is the smallest charge with which you have ever fired a 40-pounder, for instance?—I have not the particulars, but it was a very small charge, the shell dropped at 500 yards, and it did not set the fuse in action.

1023. (*Commander Singer.*) Do you ever find the tappet ring difficult to work after a few rounds?—Yes.

1024. What is the cause of that?—On firing, of course the gun recoils to the rear, and then the pressure of the breech lever on the keep pins causes it to burr, and we find that it works stiffly.

1025. (*Col. Ormsby.*) Was that the case in all natures of ordnance?—We have principally found it with the 40-pounder; all the others have kept in order, but we have had more continuous firing with the 40-pounder.

1026. (*Commander Singer.*) Have you experienced a good deal of inconvenience from that source?—Yes, we have experienced a good deal of inconvenience, we could have worked with it, but it was very inconvenient.

1027. (*Major Young.*) Does this occur after many rounds or after a few rounds?—We find, generally, first of all, when we get a new gun, that there is a certain amount of ease required, and we seldom have trouble afterwards, though we sometimes do; it is a thing which is easily put to rights.

1028. (*Col. Ormsby.*) Will you state the advantages of the Armstrong guns as broadside guns over the old smooth bores?—The rapidity of firing we find is very great as compared with the old smooth-bore guns, excepting perhaps the 110-pounders.

1029. (*Major Young.*) You compare the 40-pounder with the 32-pounder?—Yes.

1030. (*Col. Taylor.*) Have you any record of rapid firing that you could lay before the Committee?—Yes; every party with the Armstrong gun fires six rounds of independent firing at a target, and always either at 1,800 or 2,600 yards. I find that the shortest time that we have fired it in has been 3 minutes and 45 seconds; the maximum is generally five minutes excepting we have got a very stupid captain of the gun, or anything goes wrong. When I say six rounds I mean five intervals; we give the order to commence firing, and the time is taken from the first round.

1031. Do you mean that the gun is loaded previously?—Yes.

1032. You do not count the loading of the gun into the first round?—No, we start from the fire, so that it would be five intervals. I can mention some other times when we had very rapid firing with the 40-pounder. In Captain Coles's cupola, when we fired six rounds at the target in 2 minutes and 40 seconds, there being five intervals as before.

1033. (*Capt. Preedy.*) Would the effect of training the Armstrong guns be to start the breech back?—Never.

1034. Would the hand-spikesman passing to the rear striking the ring or tappet do that?—No; it would require something much more violent than that to start the screw back.

1035. (*Commander Singer.*) Do you consider the working of the 110-pounder easy?—Yes; the objections are those that I have mentioned before, namely, the difficulty of getting the shot home and the vent piece jamming.

1036. Do you consider that the ease of working of the 110-pounder in an ordinary carriage, taking it as a pivot gun, is as great as a heavy smooth-bore gun, say a 68-pounder?—It is quite as easy of working, those two disadvantages which I have mentioned excepted, which sometimes have delayed us a very long time.

1037. (*Capt. Preedy.*) You consider that the Arm-

strong 110 and 40-pounders would be as good pivot guns as the old 68-pounder?—If those difficulties that I spoke of were got rid of they would be much better, I consider; the recoil is less, and there is a shorter distance to run out.

1038. As boat guns can they be as easily handled in a boat as the old howitzers; in dismounting and mounting are the sights not likely to be damaged?—The sights would be taken out.

1039. The danger of taking out the sights in a boat is that they would be liable to slip down and be lost?—Yes; but I consider that it is necessary to remove the sights.

1040. (*Col. Ormsby.*) Supposing you lose your sights do you think that without those sights the 12-pounder gun as a boat gun is as good or better than the old howitzer?—I should prefer the 12-pounder Armstrong; it is quite as good for close quarters, and very much better for a distance.

1041. (*Capt. Preedy.*) Speaking of the broadside breech-loading gun, do you consider that it has a great advantage over the muzzle-loading gun in loading?—There are certainly great advantages in not having to run the gun in each time, and to keep it in whilst loading; it is a great advantage to get the gun out again as quickly as possible.

1042. Speaking of a ship with a little beam where there is not sufficient space to run the gun in for loading at the muzzle without exposing Nos. 3 and 4 very much, is there not an advantage in the breech-loading system?—There is a great advantage in such a case, and you can have long guns in small ships.

1043. Taking into consideration the implements necessary for the refacing of the breech-loader and the advantages in loading against the muzzle-loading gun, which would you prefer in the service generally?—I do not think much of the difficulty in facing because you might go on firing without any facing for a very great number of rounds.

1044. In an action between two ships do you not consider that by the time that would occur the gun would be rendered unserviceable?—All your ammunition would be fired away before the gun became unserviceable—150 rounds I find is the mean for refacing. I can give the number we have fired before refacing in all cases—154, 125, 153, 153, 216, and so on.

1045. What number of rounds is supplied to the Armstrong gun of a ship?—The proper proportion is 100 rounds a gun right through the ship excepting for special guns. Although we face them after 150 rounds, there is no reason why we could not go on for twice that amount; we do it because it is inconvenient to have an escape of gas.

1046. (*Col. Taylor.*) You like to have your guns in a high state of efficiency?—Quite so.

1047. (*Capt. Preedy.*) Would the escape of gas after firing 150 rounds endanger any powder that may be on the decks in the rear of the gun in charge of the powder boys?—Not in the slightest degree, I imagine.

1048. Even if the cartridge-box lid were off?—I do not think it could. With regard to refacing we find that the exercise injures the vent piece quite as much as the firing does, it burrs the vent piece, and we then have to reface it, and whenever we reface the vent piece we reface the rear of the chamber so as to have the gun efficient for the rounds that are coming on; but it is not absolutely necessary to reface the chamber. Supposing I found that the vent piece was much burred I should take it out and use another, but if the part in rear of the chamber is not much damaged I should not reface it.

1049. (*Mr. Pole.*) Who does that work on board ship?—The armourer.

1050. (*Capt. Preedy.*) Have you seen the 110-pounder Armstrong gun worked between decks?—Yes.

1051. In lifting the vent piece have you observed any difficulty from the men knocking against the beams or anything overhead?—It was considered that there

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would be great difficulty in that, and we tried it in the "Excellent," and found not the slightest difficulty, in fact the higher we found that it was up towards the beams even with the extreme depression the better we could do it, because the men were in a better position for exerting their force.

1052. Where did they stand?—They were standing on the steps of the carriage, we found in fact that it did not much matter, for whether the gun had extreme elevation or extreme depression two ordinary men could take out the vent piece.

1053. (Col. Taylor.) Have you ever tried arranging a block above on a traversing bar so as to lift the vent piece out?—It is done in Captain Coles's shield, but we have never tried it on board and do not consider it necessary.

1054. (Col. Simmons.) Is the difficulty of lifting the vent piece much increased by the rolling of the ship in a heavy sea?—We have never tried it except in a gun boat at Spithead, and there has been no difficulty in that.

1055. (Capt. Preedy.) In clearing for action at night when you could not see whether the vent piece was exactly in its place or not, do you apprehend delays or accidents in adjusting the vent piece and screwing it up?—If the drill is carried out there could not possibly be a chance of the vent piece being wrong. We have different checks; one check is in the breech screw being screwed up to a certain mark. There is a chalk mark put on the breech screw and another on the rear of the gun, and then one chalk mark is brought up to the other.

1056. You would not see that at night?—I think wherever you have fighting lanterns you can see this chalk mark.

1057. On the upper deck, for instance, could you see the mark?—In a very dark night you might not possibly. Another check is when we prime the gun, it is the duty of the captain of the gun to shake the vent piece to see that it is in its place before priming.

1058. Supposing that were neglected, what then?—If the vent piece is not in its place it will be blown out. I mentioned before that we have had three cases of that kind.

1059. (Col. Ormsby.) Does the captain of the gun screw it up?—Yes.

1060. Would he find by the feel whether it was home or not?—If he commenced screwing he would be sure to run it up to its place, but the difficulty is that the man might neglect his duty altogether. There was a case which occurred on board the "Excellent," where the vent piece was not blown out, but there was a great escape of gas, and the handles were blown off, that has been accounted for I think satisfactorily, by the primer falling down between the vent piece and the rear of the chamber; we used a very imperfect primer at that time.

1061. (Col. Taylor.) Was it a paper primer?—At that time we used the old blank musket cartridge, which was three times the diameter of the hole which it had to be put into.

1062. (Col. Ormsby.) Do you think these breech-loading guns capable of standing very rough usage in a gale of wind, or in the heat of action and so on?—As an example, I may mention that we have tried the 110-pounder as a submarine gun, that it has been fired 14 times under water, the tide flowing over and back again, that occasionally it has fallen off and gone down into a bed of mud the tide ebbing and flowing over it, and sometimes it has been two or three days under water; that I should fancy would be much rougher usage than it could ever have in a gale of wind.

1063. On board ship in action it might get struck, and it would need much more care than a muzzle-loader, and would be more likely to be injured?—The only part that projects is the lever with the handles; if that is injured you may put another on in its place; you have only to knock the pins out and put another in its place.

1064. (Commander Singer.) Are you inclined to think that the elaborateness of the gun is no objection

to its general use in the service?—Our experience has shown nothing to prevent its being used in the roughest service.

1065. (Capt. Preedy.) What means have you of dismounting a broadside Armstrong gun?—We put a tompon in the muzzle and a plug in the rear and use the runners underneath; but we sometimes use the slot, reeving the runner down through the slot, and round the plug in rear.

1066. Do you find it as easy to dismount the Armstrong gun as the old one with a swell muzzle?—There is a difficulty in that respect, it is not so easy as the other.

1067. With the ship rolling about it would become a very dangerous thing to dismount, would it not?—I do not think that the gun is properly arranged for dismounting yet; there ought to be a lip under the muzzle which has been proposed more than two years.

1068. (Col. Taylor.) I do not know that I have ever seen any large guns mounted or dismounted on board ship; but what is the danger that you anticipate from the want of that swell muzzle?—It would slip off the lashing which confines the muzzle; it is far better to have a lip than to have the projecting piece of wood from the muzzle to which the lashing has to be fastened.

1069. Are you aware that those which are now making for your service have all a swell muzzle?—That would obviate the disadvantage, although I was not aware of the fact.

1070. (Col. Ormsby.) As a whole you are entirely in favour of the breech-loader over the muzzle-loader for use on board ship, are you not?—I consider that it has very great advantages.

1071. Without going into detail, you are for the breech-loading system and against the muzzle-loading system?—I think that there are very many advantages in both systems, but I think that the balance is on the side of the breech-loading system.

1072. (Commander Singer.) Provided you could get the muzzle-loader as effective as the breech-loader would you still prefer the breech-loader?—I should.

1073. Does your answer apply to field service, boat service, and service on board ship?—I was then speaking of service on board ship, and I think that in boats the breech-loader has the advantage, there being a difficulty with howitzers in loading right forward in the bows of the boat. Speaking now only for the naval service, I think that the guns should be the same for field as for boat service, and that they should be breech-loaders.

1074. (Col. Ormsby.) Speaking particularly of your own service, if the two guns could be equally good as to accuracy and range, and in every other respect you would rather arm your ship with breech-loaders than muzzle-loaders?—Yes, I would.

1075. (Mr. Pole.) What is the form of the shot which you used in the experiments under the water?—We used the flat-headed shot in some cases where they were fired entirely under the water. It was first of all done to give an answer to all the different inventions that came out on that subject, and also to see what the actual effect would be.

1076. (Col. Taylor.) Do you remember what range you got under water?—We could not try it, we had no beach for that purpose.

1077. Was it a tidal way where you could ascertain at low water how far you got?—Yes; but the place where we had to use the gun had a raised beach in front of it, which is only just covered with water at high water; whereas the gun itself was six feet under water.

1078. (Commander Singer.) Did you intend the Committee to understand that the shot fired under water were in all cases flat-headed?—In some cases they were flat-headed, in others they were common shot.

1079. (Mr. Pole.) Did you try it with conoidal shot?—Yes.

1080. With what effect?—We found that the penetration with the common service shot was better than with the other.



1081. You stated in one of your answers that the spherical head would not penetrate under water; what did you mean by that?—I meant that if the gun were out of the water and you attempted to hit a ship below the water line you could not do it.

1082. What happens in that case?—The shot deflects and rises immediately, it enters the water to a very small depth.

1083. (*Major Young.*) If you fired at a very high angle it would hit the ship?—Of course it would if you go to a certain limit, but we fired at the extreme depression which the carriage would admit.

1084. Was that about five or six degrees or more?—From six to eight degrees is the greatest amount of depression that the carriage will give; the port generally gives about six degrees; the actual firing was from seven to eight degrees.

1085. (*Col. Ormsby.*) Will the flat-headed shot penetrate under water?—Yes.

1086. (*Mr. Pole.*) In both cases the flat-headed shot will enter the water and pursue its course while a round-headed one will not but is deflected upwards?—Yes, it is deflected upwards.

1087. The flat-headed shot penetrated and the other shot did not?—This is what I say in the record of the experiments; that the Armstrong common shot was deflected upwards, but I read in this book which I have in my hand that with a Whitworth 24-pounder howitzer the same experiment was tried and the shot penetrated under water; I did not see that myself but I saw the experiment with the Armstrong gun.

1088. (*Col. Ormsby.*) Do you think that the Armstrong segment shot has as great a smashing effect against ships as the old 68-pounder round shot for instance?—It would not make so large a hole, it being so much smaller in diameter, so that it would not produce so great a smashing effect; but then it would penetrate at distances where the other would only just graze the ship.

1089. Upon the whole you think that the Armstrong gun has a greater destructive effect against ships?—An immensely greater effect if you take all the circumstances into account.

1090. (*Capt. Preedy.*) As far as your experience goes which gun do you consider the best for cupolas?—I consider that it is a very great advantage in cupolas to have a breech-loading gun, but what I read is that there is a great difficulty in constructing those guns. The great advantage of a breech-loading gun for a cupola is this, that the gun completely fills up the port when mounted in the way that Captain Coles mounted the one in the "Trusty," and there is no place at all for any splinter to come into the shield, four inches was the greatest space for anything to enter.

1091. What sized gun are you speaking of?—I was then speaking of the 40-pounder.

1092. (*Commander Singer.*) As far as you know you consider the 110-pounder to be the best adapted for cupolas?—It is better adapted than the 68-pounder or any other gun that I know of.

1093. (*Capt. Preedy.*) With a muzzle-loading gun in a cupola you must have the crew exposed, must you not?—More exposed, the port would have to be much larger in fact, while the gun is loading there is a larger space comparatively exposed equal to the diameter of the gun added to the angle of elevation and depression; it could not be mounted in the same way that I speak of.

1094. (*Commander Singer.*) You are aware how Captain Coles intends to obviate that danger, that he intends to have the guns loaded with the port pointed away from the object?—Quite so.

1095. Do you consider that the service projectile with the 12-pounder is satisfactory for the general service that it is intended for, for boat and field service?—I consider it satisfactory.

1096. And do you consider the projectile for the 20-pounder satisfactory for the service that it is

intended for?—I consider all the projectiles satisfactory excepting for the 110-pounder.

1097. What is your objection to it?—That there is no projectile to fire against iron plates; all the others are very satisfactory.

1098. Do you consider their liability to be injured by carriage or rough handling or time rendering them unfit for use is very great?—I think that in transferring them there is a danger of their being dented and thereby made difficult to enter into the gun; but our experience has shown that a small dent is easily smoothed out so as to enable the shot to be rammed home.

1099. Have you ever seen the lead in a 110-pounder shot or shell so much deformed as to render it impossible to load for a considerable time?—The only case of that sort that happens is this, we have a kind of regular exercise shot which of course gets dented from being continually thrown about.

1100. If I understand you rightly, you do not look upon the liability to injury as any great objection to that description of projectile?—No, not if it is once in its place on board ship.

1101. (*Major Young.*) Would dropping it on deck alter its form?—Not so as to prevent your ramming it home.

1102. (*Capt. Preedy.*) Supposing that in a gale of wind the shot get loose, would they not be damaged from rolling about the ship and from the violent lurching of the ship?—Yes, if they came against any metal they would get dented so as to render it difficult to load.

1103. That is a thing which very often happens in a gale of wind, is it not?—Yes, but they would not roll about the ship to the same extent as round shot.

1104. (*Col. Ormsby.*) But would they not be easy to repair?—Yes, you could hammer them out.

1105. (*Col. Taylor.*) Do not you think that any such injuries as that you would be able to repair on the very first fine day or two afterwards?—Very easily indeed; there would be no difficulty at all about it; it is simply hammering them out. I have seen cases where they have been dented, and when we have entered the shot and found that it would not go beyond a certain point, we have taken out the shot and hammered it out with a linch pin or anything else, we have then rammed it home and it has been just as good as any other.

1106. (*Commander Singer.*) Have you ever seen a heavy shot, for instance, a 110-pounder, so dented as to be useless?—None, except some of the exercising shot; and even they could be reamed off.

1107. (*Capt. Preedy.*) Have you seen those guns and shot used in a sea-going ship?—No, only on board the "Excellent," and in gun-boats. The greatest amount of firing that I have seen with motion was from an Armstrong gun against Captain Coles' shield, and occasionally it was a little rough.

1108. (*Mr. Pole.*) In saying that the 110-pounder had no projectile to fire against iron plates, did you refer to the material of the projectile?—To the material and to the shape.

1109. With respect to the material, do you consider that cast iron is too easily broken?—Yes, it is too easily broken.

1110. And with reference to the shape, what is your idea?—There can be no doubt from what I have read, and the experiments which we have carried out, as well as others, that the shape is not suited as regards the form of the head.

1111. Do you think that a flat head would be better than a round head?—It would appear so; I only speak of it from what I have read. I have not seen a flat-headed shot fired against iron plates.

1112. (*Col. Ormsby.*) But you have seen a round-headed shot fired against them, have you not?—Yes, a great number.

1113. And they failed?—They did not appear to me to be quite as good as the 68-pounder.

1114. (*Major Young.*) Have you seen any reports or heard anything about flat-headed cast-iron shot

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being fired against iron plates so as to be able to make a comparison between the flat-headed and round-headed shot?—I have not seen any reports and what I speak of now is merely from hearsay, not being my own experience. I think that when Mr. Whitworth's gun was tried it was from the very first with a wrought-iron shot.

1115. (*Mr. Pole.*) Have you seen the effect of an ordinary wrought-iron shot upon a plate?—I have seen it fired from a 68-pounder.

1116. Have you noticed how they double up and set up?—Yes.

1117. Have you noticed the effect upon the plate?—In each case the plate has been punched into the ship's side. The effect has been very much greater than with cast iron.

1118. (*Col. Taylor.*) Have you ever seen instances in which a wrought-iron shot has gone clean through a  $\frac{1}{2}$ -inch iron plate?—Never.

1119. It has always set up and fallen back, has it not?—I think once or twice it remained in the fracture.

1120. (*Capt. Preedy.*) Speaking of broadside guns, do you consider that there is less liability to accident to the guns' crews in working those guns than in working corresponding smooth-bore guns?—Yes, there is less liability to accident from the enemy's shot, but really there is not very much difference, I mean from a shot coming through the port.

1121. In sponging and loading there is great danger with a smooth-bore gun which you get over by breech-loading?—Quite so. I consider that if this liability to the vent piece being blown out were done away with there would be no danger at all to the men at the gun.

1122. In sponging and loading a smooth-bore gun there is always danger, is there not?—There is never any danger if they sponge and load properly, except of course when the gun is in bad order.

1123. (*Commander Singer.*) With respect to the service fuses, are they satisfactory now?—We have not received the new service time fuses yet; I have only seen the percussion fuses fired at Shoeburyness; we have not tried them on board the "Excellent."

1124. (*Col. Taylor.*) You have not seen the last pattern time and concussion fuses have you?—I have seen the concussion fuses, the small brass ones.

1125. Have you found them answer well?—We have had very little practice with them, but what we have seen has been very satisfactory, but we have nothing to fire against which will show the fuse properly. We have no wooden targets to fire against, we only judge by the graze on the water, and at the great distance that we fire we are not always very certain whether it has been a burst or no.

1126. I suppose from your position you can scarcely fire a 110-pounder with a common shell with the common service charge?—We have never fired 110-pounder shells with full bursters except at Spithead; two or three shells which we fired with reduced bursting charges in harbour burst in the gun.

1127. (*Commander Singer.*) Have you seen a shell burst in the gun?—I have seen the effect of it after it has burst.

1128. Do you consider that that is likely to injure the gun so much as to render it unserviceable?—When that occurred in our gun we went on firing and it did not appear to injure the gun at all.

1129. Did it appear to affect the accuracy?—Not at all.

1130. (*Major Young.*) Was it reparable by your own armourers?—It could have been if the armourers had been properly trained to the use of the special tools.

1131. It was not necessary to return the gun to the Arsenal?—Certainly not; the gun in which this accident occurred has been repaired on board the "Excellent" by artificers sent from the Arsenal, simply because we have not a large complement, we have only one or two armourers.

1132. (*Col. Ormsby.*) With respect to the 12-pounder,

do you think that the segment shell used as shot is quite sufficient on board, and effectual enough without having solid shot as well?—Certainly; I have seen those which had gone through a great amount of wood, and they only appeared just flattened a little.

1133. Does the same thing apply to the larger guns?—Certainly not, it would be incurring a great expense for no object. In a ship there is no difficulty in stowing the different projectiles, but for field and boat guns there is an immense advantage in having only one species.

1134. (*Col. Taylor.*) Do you consider that a segment shell fired as a segment shell is under certain circumstances a valuable projectile for naval purposes?—I think it is a most admirable projectile.

1135. For bursting it as a shell before reaching a vessel, for instance, do you contemplate using it in that way?—It has never been contemplated to use it in that way against vessels, but against boats it has.

1136. Under certain circumstances do not you think that devoting one or two guns to keeping up a fire of segment shells on the deck of a ship, bursting a little short of a ship would make it very difficult for the enemy's crew to stand to their guns and work on the upper deck?—I would rather fire common shell at the ship, because you cannot estimate your distance, the object would be changing the distance too rapidly.

1137. (*Major Young.*) In attacking an iron-plated ship would it not be well sometimes to try and reduce the number of her crew?—If I had no projectiles that would go through the ship it would be the best way no doubt.

1138. (*Capt. Preedy.*) For firing against boats have you any projectile supplied to the Armstrong guns equal to the grape and canister of the smooth-bore guns at a distance of 200 yards?—I consider that the segment shell is a most admirable projectile, but I have doubts whether it spreads soon enough for that very short distance that you speak of.

1139. Would you have the same confidence in keeping off boats with the segment shells supplied to Armstrong guns as with the old grape and canister?—I should have greater confidence than with the old grape and canister, because I could use them so very much sooner and with greater effect, but when they come very close I doubt their having the same amount of spread; the one thing counterbalances the other; that it bursts in so many more fragments is an immense advantage in the segment shell.

1140. If the boats on a dark night succeeded in getting within 200 yards of a ship, the segment shell would be, comparatively speaking, of very little use, but canister and grape would spread immediately after leaving the gun, would they not?—I doubt whether shell would spread so soon. Every party of men that passes us has to fire, using the time fuse set at 0°, so as to burst on leaving the muzzle. Sometimes it may be that the time fuse has not been acting well, and both have failed to act until the shell has left the muzzle 40 or 50 yards. I have seen other cases where it has burst beyond that, and I have been watching particularly to ascertain at what distance it burst.

1141. With a segment shell you require a fuse of course?—Yes.

1142. With grape and canister you have merely to put them into the gun and fire them off?—Yes.

1143. Supposing you knew that you were going to be attacked at night by boats, if you had the choice of rifled guns and smooth bore guns, which guns would you prefer to resist those boats?—I have not had any experience to show what the spread of those shells is.

1144. One spreads immediately it leaves the gun and the other will not spread until the fuse acts, and that you say is at a distance of perhaps 50 yards from the muzzle of the gun?—Perhaps I was wrong in saying that at the distance of 200 yards the segment shell would not be so good, but I have not had



any actual experience by trying it against screens or anything of that kind.

1145. (*Col. Simmons.*) If you had both the time and the concussion fuse in one of those segment shells could not you depend upon its bursting short of the boat by striking the water at a certain distance in advance of the boat?—Even if you make it strike against the water your concussion fuse will take a certain time; it does not act till it comes about the height of a man generally speaking.

1146. (*Commander Singer.*) Have you given any evidence with respect to the breech screw of the Armstrong gun?—I have memoranda as to the breech screw having got out of order.

1147. Do you consider that the breech screw of the Armstrong gun is weak and likely to give trouble in actual service from the thread stripping?—The breech screw of the new pattern guns has never yet given any trouble; the breech screw of the old pattern guns got out of order on several occasions from the rectangular threads having given way, but since we have had the new pattern guns we have never had the slightest trouble. We have fired from the new 40-pounders as many as 574 rounds, and we have only had them a few months.

1148. (*Mr. Pole.*) I presume that you have a feeling of perfect security with reference to the wrought-iron guns made in the new way with respect to their bursting?—Perfectly so.

1149. As perfect as with any gun that you have ever known in the service?—More so than with the old cast-iron guns, because there have been occasionally bad castings.

1150. (*Col. Taylor.*) Do you not consider it a very great element of security that the wrought-iron coil gun will always show defects before it bursts?—Certainly.

1151. (*Mr. Pole.*) Have you ever seen it when the coils have given way from practice or anything of that kind?—We have had flaws in the guns on board the "Excellent;" they were simply pointed out because the gun was then in its infancy, but they were never considered by any of the officers of the ship as being at all dangerous.

1152. (*Chairman.*) No accidents have resulted?—No accidents have resulted.

1153. (*Col. Ormsby.*) Nor have they become unserviceable from the coils giving way or opening?—No.

1154. (*Mr. Pole.*) It was at an early period that those flaws were observed?—Yes; if the same flaws were seen now we should think nothing of them. With reference to the breech screw having gone, I may mention that in every one of those instances we had only to put in a spare screw and it would have answered as well. We are allowed a spare screw for every six guns, so that the gun would not have been rendered unserviceable by that particular screw being injured, because we did not find that the threads of the female screw became injured, only those on the breech screw.

1155. (*Mr. Pole.*) What was the nature of the injury?—The threads broke across, and by coming out from the barrel they rendered it difficult to screw up or unscrew.

1156. Was that injury spontaneous or from a blow?—From the firing.

1157. (*Col. Ormsby.*) Several inches might have come off the thread of the screw and you might have fired the gun afterwards?—We have fired when it has come off from the end. The part which I was speaking of in the 40-pounder where the injury occurred was more in the centre of the screw; what you are speaking of now refers to the end of the screw; we have cut off as much as a foot from the end when it has become injured by knocking against anything.

1158. And still it has answered its purpose?—Yes, perfectly.

1159. Do you think that there is any disadvantage in those guns for sea service owing to their being

generally of much smaller calibre than the old smooth bore, and from their greater recoil?—The smaller calibre is much more than compensated for by the greater burst of the shell. We carried on some experiments the other day with reference to a letter from Sir William Martin; he had asked to have the breechings made stouter for the 40-pounder on account of the excessive recoil, and he wished to draw a comparison between that gun and the 8-inch gun. We fired them with all the trucks off and with the breeching and side tackles unhooked, so that there was nothing to prevent the recoil to the rear; and we found that the 40-pounder recoiled 8'9 feet and the 8-inch gun 7'4. The 8-inch gun was fired with the highest charge, but when we fired it with a double shot and a full charge, which is permitted, under exceptional circumstances, the 8-inch gun recoiled as much as 9'10. I mention that to show that the recoil of the 40-pounder is very little more than that of the 8-inch gun.

1160. (*Col. Taylor.*) Was that without any compressers?—It was a common four truck carriage on the deck with all the trucks taken off, and with the breeching and side tackles unhooked.

1161. Was it a broadside gun?—Yes.

1162. (*Capt. Preedy.*) In both cases were the trucks removed?—In both cases.

1163. Are you aware of the breechings having been carried away in the Mediterranean as has been mentioned?—They have not been carried away, I know, because the question was put in correspondence asking for the 40-pounder to be allowed a 9-inch breeching. I may state with reference to this question that we have used one breeching whilst firing 1,000 rounds from 40-pounders, and at the end not a strand of the breeching had gone, nor was it seriously injured.

1164. In the experiments you made the ship was on an even keel; but supposing the ship had been heeling over four degrees, what would have been the effect?—Then the increase of the recoil with the 40-pounder would be just as much as with the 8-inch gun.

1165. What is the breeching of the 40-pounder gun?—The breeching is the same as that of the 32-pounder (8 inches).

1166. In an 8-inch gun the size of the breeching is 9 inches, is it not?—Yes; the reason that I mentioned the 8-inch gun was, that in Captain Stewart's report he said that the recoil was greater than with the 8-inch guns, and that is the reason why the 8-inch gun was tried against the 40-pounder. With respect to the 110-pounder, using the naval compressers the gun never comes in taut breech; the recoil is about 5'6 on the slide when the outside compressers are set up. The 68-pounder and the 10-inch gun have a greater recoil than the 110-pounder gun certainly. With respect to the injury to the gun by firing, I may mention that we went on for a period of three months or more, during which we fired 300 rounds without cleaning out the gun once.

1167. Did you use the lubricating wad?—Yes; we always use it. The gun that we are carrying on our practice with, we never sponge at all.

1168. Do you consider the lubricating wad an objection or an advantage, taking everything into consideration?—It has this great advantage, that it renders the sponging unnecessary, and enables the shot to go home into its seat better.

1169. Then the stowage is the only objection which you see on board ship, is no time lost through using it?—There is very little time lost while it is being screwed on the cartridge. We screw it on when it is brought up to the gun; it is not kept in the magazine on account of the very large magazine which would be required.

1170. (*Col. Taylor.*) That is to say, if you carry a large number of them?—Yes.

1171. (*Col. Ormsby.*) You stated, did you not, that you fired six rounds in two minutes and three quarters?—Yes; that was in Captain Coles's shield.

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1172. Did you use the lubricating wad on that occasion?—Yes, without any screwing up; then it was the old wad which had to be pushed down the slot. My object in mentioning that circumstance was to show what could be done with the guns. I may also mention with reference to firing that in an experiment nine months ago we fired 100 rounds right off from a 40-pounder gun in 86 minutes, using two guns' crews; 25 rounds with one gun's crew, and then the other gun's crew came in and fired 25 rounds, changing the crews every 25 rounds.

1173. Did you use the same vent piece?—No, not the same vent piece throughout; the ring came off the vent piece after a certain number of rounds.

1174. (*Commander Singer.*) If I remember rightly the ring did not come off till the gun had fired 80 rounds?—It was by far the greater number. I could find out what the actual number was.

1175. (*Col. Simmons.*) Did you find the vent piece get inconveniently heated by that rapid firing?—Nothing to prevent the working at the handles, and the gun did not get particularly hot; in fact the gun was hotter some time afterwards than it was when we finished the practice.

1176. (*Capt. Preedy.*) Had the vent piece been used before this experiment?—It had; it is a peculiar thing, but we have had no vent piece belonging to a 40-pounder carried away on board the "Excellent;" but when our guns were taken out to a ship at Spithead, two were carried away, one after the other.

1177. (*Col. Taylor.*) Was that by your own men?—No, not by our own men; they were sent out in the "Chanticleer," trying experiments.

1178. (*Capt. Preedy.*) When this ring came off did you use the same vent piece?—No, another vent piece; we are allowed two spare vent pieces for every gun; every ship going into action would have a spare vent piece ready.

1179. (*Col. Simmons.*) There was no jam, was there, or anything to prevent your withdrawing the first vent piece?—No. When I spoke of 86 minutes, that was subjected to every kind of check. The first check was by the trigger line carrying away, another check was that the bed became unbolted, and we had to turn the gun so as to rebolt it; all those times were taken into account, so that it should be as much as possible like an action.

1180. Did that include screwing in the wads?—Yes, everything, and the targets were at the same distance as I mentioned before, 1,800 and 2,600 yards.

1181. (*Capt. Preedy.*) Was the gun pointed each round?—Every round and the shooting was remarkably good.

1182. (*Col. Simmons.*) What was the size of the target?—At 2,600 yards the targets were 12 feet square, in other cases they varied; we knocked them to pieces, and we had to put up canvas ones quite ten feet square.

The witness withdrew.

Mr. EDWARD BECHERVAISE examined.

1193. (*Chairman.*) What are your duties?—I am a gunner in the navy, employed as instructor of the Armstrong gun on board the "Excellent."

1194. How long have you been so employed?—Since the first introduction of the Armstrong gun; three years next March.

1195. Could you give the Committee some idea of the practical working of those guns?—Yes.

1196. (*Commander Singer.*) With respect to the range of the Armstrong guns, do you consider it everything that could be wished for general service?—Yes.

1197. What is the extreme range at which you may make good practice under ordinary circumstances at sea?—I should think between 3,000 and 4,000 yards, under very favourable circumstances.

1198. You do not mean to tell the Committee that

1183. Have you recorded the number of hits that there were in that 100 rounds?—We register our number in this way. If a shot comes within a certain limit we say that it gains six numbers, and we call a shot a bad one if it gains less than five. We expect with an Armstrong gun for a man to gain five numbers per shot, or he does not fire well.

1184. (*Col. Ormsby.*) How near is that to the target?—It would vary in some degree with the distance; but with a smooth-bore gun at 1,000 yards if a shot goes within four yards either one side or the other then it gains three numbers, and if it goes within 40 yards over or under we allow three more. There are three numbers given for direction and three numbers given for elevation.

1185. What number is given for hitting the target?—Six; we cannot gain more than six; we do not consider a man a bad shot, using the rough manner of pointing which we are compelled to do, if he does not hit the target, but just goes past right or left of it; a ship is always sheering about even when she is in harbour.

1186. (*Col. Taylor.*) You attach very great value to range when the ship is slightly moving, because that is one of your greatest difficulties at sea?—Yes, we do, and we arrange it in the same way.

1187. Would you like to make any remark upon the facility of stowing a vessel's ammunition on board in the magazines. Do you reckon that the number of rounds, we will say for 100 broadside 40-pounders, would take up more room than the ammunition for a corresponding smooth bore gun?—You must take another thing into account, namely, that where we have now 32-pounders we shall have 70-pounders, because they are the same weight.

1188. Supposing the 32-pounder superseded by the 40-pounder, what difference would there be in the stowage of powder?—It would allow of a great deal more room in the magazine, I have no doubt.

1189. (*Commander Singer.*) How many 5 lbs. cartridges could you stow away. Could you stow away as many you used to do?—We cannot stow away as many 5 lb. Armstrong charges in a case as we could the 5 lb. 32-pounder charges. The number is 13 40-pounder as against 22 32-pounder; but 5 lbs. is the minimum charge for the 50 cwt. 32-pounder.

1190. (*Col. Taylor.*) But you have not to carry so large a quantity of junk wad as you used to carry?—We only have a very few rounds of junk wad, perhaps half a dozen for each gun.

1191. You do not consider that the rifled gun entails a larger space for its ammunition?—Certainly not, if you compare the 40-pounder with the 32 pounder.

1192. (*Capt. Preedy.*) Have you any further information to offer to the Committee from your own experience?—No, I think I have gone through all that I wish to state to the Committee.

you consider that good practice might be made at sea, in ordinary weather, at between 3,000 and 4,000 yards?—If the ship was without motion it might be.

1199. I mean in ordinary weather at sea?—I should not say that good practice could be made at that range.

1200. In fact, the range is everything that you require for ordinary service?—Yes, in my opinion it is.

1201. You have seen a great deal of firing. Do you consider the accuracy everything to be desired?—I think so.

1202. Do you allude to every description of Armstrong gun that you have had experience of?—Yes, I think so, excepting the 20-pounder. I consider that the accuracy of the 20-pounder is not equal to that of the other natures of guns.

*Mr. E. Bechervaise.*



1203. Do you consider that the defect of that gun in accuracy exists to a very great extent?—Not to any great extent, but certainly it is less accurate than the others.

1204. You allude now to the shortened 20-pounder?—Yes, I allude to the naval boat gun.

1205. Still you consider that the Armstrong gun is a good serviceable gun for the purposes for which it is intended, namely field service and boat service, so far as accuracy is concerned?—Yes.

1206. (*Capt. Preedy.*) As broadside guns, do you consider the Armstrong 70 and 40-pounders as easily worked and trained as the old 68 and 32-pounders?—I have never seen the 70-pounder; we have none.

1207. Is the 40-pounder as easy a gun to work as the 32-pounder?—Yes, quite so.

1208. Have you had any experience with the 110-pounder as a pivot gun?—Yes.

1209. Is it as easily worked as the 95 cwt. 68-pounder?—So far as the traversing and shifting from one bolt to the other is concerned, I consider that it is so; but in firing we have had some little delay owing to the jamming of the tin cups.

1210. Will you explain the cause of that?—In loading the tin cup which is used after the cartridge to prevent the escape of gas has on some occasions jammed the vent piece, a part of the tin has been blown between the seating in the rear of the chamber and the face of the vent piece, so as to prevent the vent piece being taken out again by hand until it was prised back by a lever.

1211. Had you any great difficulty in removing the vent piece after you found it jammed?—Yes, there has been a difficulty.

1212. What delay occurred on such an occasion?—I have known a delay of some two or three minutes.

1213. Not longer?—I think not, speaking to the best of my recollection.

1214. Would the effect of the extreme training of the Armstrong gun in lifting the carriage off the deck be to start any portion of the breech, so as to render it necessary to readjust it before firing?—I have never known an instance of that. I have known an instance of the elevating screw running down from extreme training, but not of the breech screw starting.

1215. In clearing for action at night in a sea-going ship, do you apprehend delays or accidents in placing the vent piece in after loading?—I do not know that there is any reason why there should be any. I cannot speak from experience, because we have never tried it.

1216. How long is it since you have been at sea?—Three years.

1217. For a sea-service gun would you prefer the breech-loader to the muzzle-loader?—I think I prefer the muzzle-loader.

1218. Why?—It is very much simpler, for one reason; there is less complication about it.

1219. Would there not be less danger with the breech-loader than the muzzle-loader to the crew, for instance, in sponging and loading?—I do not think there is danger in either case if proper precaution is taken.

1220. Accidents have occurred in muzzle-loading guns which it would be impossible could occur in breech-loading guns; do not you consider that a great advantage?—I think they are about equal in that respect.

1221. Have you had any experience with the Whitworth gun?—Very little.

1222. Has the little experience you have had given you a clear insight into the practical working of that gun?—No, I have not had sufficient experience for that. I saw some nine or ten rounds fired from it, I think, two years ago.

1223. Have you seen any accidents occur to the vent piece of the Armstrong gun?—Yes, I have seen three accidents.

1224. Will you describe them?—In the first the head of the vent piece was blown off, and the great escape of fire between the vent piece and the rear of the chamber blew down the bulk heading of the sick

bay, and also the cabins on the middle deck of the "Excellent."

1225. Would that explosion have ignited any charges in the cases on deck?—No.

1226. Had the tops of the cases been off, do you think that it would have ignited any charge in a case at the rear of the gun?—I think not.

1227. Did it ignite any loose powder on the deck on that occasion?—No.

1228. Supposing the cartouche boxes for the rifles had been kept in the usual cases near the gun overhead between decks, would it in your opinion have ignited the charges in those cases?—It might if they were immediately over the vent of the gun but not otherwise.

1229. Can you inform the Committee of any other accidents?—Yes. The second case that occurred was this; the vent piece of a 20-pounder was blown out, and in that case also a portion of the bulk heading was knocked down.

1230. What became of the vent piece?—It struck the beam immediately over the gun and dropped down close alongside the gun.

1231. Did it injure the beam?—Yes.

1232. Did it spring it?—No; it did not spring it, but it cut a piece out of the beam the size of the part of the vent piece that went into it.

1233. Had the gun been on the upper deck a serious accident might have occurred, might it not from its falling again?—Had it fallen on board the ship it might have done so.

1234. Will you state the cause of the vent piece blowing out?—It was from the breech not being screwed up.

1235. From the neglect of the captain of the gun?—Yes.

1236. In both cases?—No. In the first case I imagine it was not from the want of screwing up, but that something got between the rear of the chamber and the face of the vent piece.

1237. Was it so ascertained?—It could not be clearly proved, but there evidently had been an attempt made to screw up the breech because it was impossible to remove the vent piece without turning the screw back again.

1238. (*Col. Taylor.*) The vent piece in that case jammed in the slot, it was not blown out, was it?—It was not blown out—the head of the vent piece, the cross arms, were blown off.

1239. (*Capt. Preedy.*) What was the third case to which you alluded?—The third case happened with a 40-pounder on the main deck of the "Illustrious."

1240. From the same cause?—From the same cause as the second, from the breech not being screwed up.

1241. (*Col. Simmons.*) Did the vent piece blow out in that case?—Yes.

1242. Did it do any damage?—It struck the carline of the beam immediately over the gun, and cut into it in the same way as the 20-pounder did before.

1243. (*Capt. Preedy.*) It did not go through the deck?—It did not.

1244. (*Col. Taylor.*) It would if it had not struck the carline?—I think so.

1245. (*Capt. Preedy.*) Have you been sent away in charge of boats when they have been armed with the Armstrong guns?—I have never been in charge of a boat, but I have been in the boat during the time of firing for experiment at different times, trying recoils, &c.

1246. In arming the boats have you found any difficulty in placing the Armstrong gun in the boats in the usual mode of putting them in by the tackles?—None any more than would be found with the old gun.

1247. In manning and in hoisting out the guns from armed boats are the sights fixed on the guns?—The trunnion sight would be fixed but the tangent sight would be removed.

1248. (*Commander Singer.*) Do you think that the new trunnion sights would be left on the gun?—Perhaps not, we have had no boat guns fitted with that description of sight yet.

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1249. (*Capt. Preedy.*) Where are the sights belonging to the boat guns usually kept?—On the guns themselves.

1250. When an order is given to man a ship's boats in a hurry what becomes of those sights?—I should think the men who were stationed to sling the gun would be at the same time stationed to pass the sights into the boat.

1251. Do not you think they would be likely to be lost in being passed into the boats?—I think there would be less liability of their being lost in passing into the boats than there would be of their striking against something in hoisting out the gun.

1252. Then in arming the boats, or dismounting, or mounting, in each case you are obliged to remove the sights to protect them?—Yes, I think so; the tangent sight at all events.

1253. Was it necessary to remove the sights in the old guns?—No.

1254. Do you not conceive that to be an objection, to the present gun so far as boat service is concerned?—Not a very great one.

1255. You recollect when on service in manning and arming boats how many little things are forgotten after the boats leave the ship when they are inspected by the inspecting officer?—Yes.

1256. Do not you think that in the case of manning and arming boats and sending them away in a hurry those little things would be likely to be misplaced or forgotten or thrown over board?—I should think it hardly possible having that kind of gun that they would be forgotten.

1257. Where would the man put them, he must carry them in his hand going down the ship's side because he has no other place to put them in, he has no pocket?—Precisely.

1258. Could a sight be fixed so as to render them serviceable for boat service without their being removed, inasmuch as you do not require the same accuracy in boats where the motion is so very quick, and you do not require the delicate sight for boat service that you would for other services?—In the case of making a plain sight of it, the same as the old sight, I think it might be kept at the gun with safety in hoisting it.

1259. (*Col. Taylor.*) Have you not the ratchet sights on the guns which are issued for boat service the same as we have on the land guns?—Yes, on the old pattern guns there are the ratchet sights but in the new patterns there are not.

1260. (*Commander Singer.*) Is there a ratchet sight on the 20-pounder?—Yes, the 9-pounder is the only gun that has not it.

1261. (*Major Young.*) You are quite sure that there is no ratchet sight in the new field and boat guns?—There is none on the 9-pounder gun.

1262. (*Col. Ormsby.*) Supposing that you took those tangent sights out of the gun and they were dropped overboard and lost altogether, would not the gun be just as well sighted as the old gun without the tangent sight at all?—Yes, I could make a wooden sight in a very few minutes.

1263. But without making a wooden sight, merely using the sight which you have?—Yes, I could with a ratchet-sight for short ranges.

1264. What sight had you in the old boat guns?—Only the common tangent sight on the centre of the gun. Good practice may be made with the 20 and 12-pounders by the ratchet sight at the same ranges that good practice may be made with 24 and 12-pounder howitzer.

1265. (*Col. Taylor.*) In point of fact the ratchet-sight is quite as good a sight as the old one; and you have the difference of the greater comparative accuracy of the rifled gun?—Yes.

1266. (*Commander Singer.*) You have had great experience, have you not, in surfacing, and the use of the special tools for the Armstrong gun?—Yes.

1267. Do you find any defect or any difficulty in resurfacing the vent-pieces or the rings in the rear of the chamber?—I have never found the slightest

difficulty with the ring in the rear of the chamber, but in surfacing the vent piece I have found a difficulty.

1268. Do you suppose that on service there would be many rings spoilt in the surfacing and by bad workmanship?—I think that very probably there would be.

1269. (*Col. Taylor.*) Would you explain what the difficulty is which you experience in facing a ring or vent piece?—We find it impossible to get the vent piece to lie fair in the slot, so as to make the cutter fit the surfaces, and the face of the vent piece take it evenly.

1270. Do you not insert a piece of flat wood in advance of the vent piece, between it and the rear of the powder chamber?—Not in the 40-pounder; in the old pattern guns there is no room in the slot to do so; there is only just room for the vent-piece.

1271. In the 12-pounder you would?—In the 12-pounder we have pieces of wood supplied for that purpose with the surfacing tools, and in the 20-pounder also.

1272. (*Commander Singer.*) Are you of opinion that the comparative elaborateness of the breech-loading arrangement in the Armstrong gun is an objection to it for general service?—I think not.

1273. You do not consider it likely that much if any inconvenience would arise from it?—No; with regard to the ring upon the vent piece, where it cannot be easily surfaced, a new ring can be put on in a very few minutes.

1274. Do you consider that the present service vent pieces are weak?—The vent pieces in the 100-pounder are still weak; in the 40-pounder I think they are sufficiently strong to answer all purposes.

1275. And for the lower description of guns also?—I think so.

1276. With respect to the breech screws, are they weak, and do you think it likely that you will have any trouble with them from the thread springing from the body of the screw?—I do not think it is likely with the present form of thread.

1277. With the old rectangular thread there was that danger, was there not?—I think so.

1278. With the present bevelled thread you think there is no danger?—No.

1279. (*Capt. Preedy.*) Have you ever completely stowed a magazine with the Armstrong ammunition?—We have one on board, but I did not superintend the stowing of it, and therefore I could not speak with any accuracy about it. I mean a boat's magazine.

1280. Has the magazine of any description of vessel to your knowledge been stowed with the ammunition for Armstrong guns only?—I cannot speak upon that point with accuracy.

1281. Are you aware whether any greater space is required for the ammunition for the Armstrong gun than for the old charges; do the cartridges for the Armstrong guns take up more space than for the old smooth-bore guns?—I think not.

1282. (*Commander Singer.*) How many 5 lb. cartridges do you put in a whole case for a 40-pounder?—I cannot say.

1283. (*Capt. Preedy.*) Can they be stowed in Dell's cases?—Yes.

1284. Do the Armstrong shot and shell require greater care in stowage than the old ammunition?—Than the old round shot they do, but not greater care than the old grape or case.

1285. Have you seen any cases of lead stripping off from the shot in firing?—I have not lately.

1286. Do you consider that the projectile for the Armstrong guns is liable to injury from the effects of travelling or rough handling?—The lead may become dented, but I have found in cases where it has become dented that it is easily put right again.

1287. Have you ever seen a case of a shot being so injured by being knocked about that it could not be fired, say in the space of five minutes?—No, I have not.



1288. (*Commander Singer.*) Have you seen anything of the new pattern service fuses?—I have seen the new concussion fuse, but not the new time fuze.

1289. From what you have seen of them do you think they are satisfactory in their action or not?—I have not had any experience of the firing of them.

1290. Have you seen the new service time fuse at all?—No.

1291. You consider the old service time fuse unsatisfactory?—Quite so.

1292. Is there any great objection to using the adapter to the larger description of shell?—Yes; the principal objection to it is its being a right-handed thread for the fuse hole, and a left-handed thread for the fuse of the shell, and in screwing in the time fuze it is very liable to start the adapter, and then from the rotation of the shell. I am of opinion that either the adapter or the time fuse comes out, during the flight of the shell occasionally.

1293. Why do you imagine that?—I have seen shell picked up after firing, some with the adapter remaining in and others with the adapter and fuse out.

1294. (*Capt. Preedy.*) Could that difficulty be got over by altering the direction of the thread of the screw?—I think so.

1295. (*Col. Taylor.*) You say that you have found some of the shell with the adapter out?—I have seen them.

1296. Have those shells grazed upon the ground?—They have gone into the mud.

1297. They have been in contact with the ground?—Yes.

1298. (*Commander Singer.*) Have they ricocheted?—That I cannot say. I saw them at the magazine.

1299. (*Col. Taylor.*) Have you any rule for the

prevention of those accidents?—We give directions that the adapter is to be screwed in as tight as possible.

1300. Then with respect to the fuse, what directions do you give?—To tighten that to the adapter also. In the case where the thread of the adapter goes one way and the thread of the screw the other, the direction which I give is that they should screw the adapter in to the utmost, so that they shall be able to get sufficient firmness with the fuse screw without reaching the holding power of the other.

1301. Do you not think that it would be better to have both the screws working the same way, so that the second screw would only fortify the first?—I think so.

1302. (*Commander Singer.*) Do you instruct the men to put the adapter on to the fuse or to put the adapter into the shell and then screw the fuse into the adapter?—To put the adapter into the shell and then to screw the fuse into the adapter.

1303. (*Col. Ormsby.*) You stated that you prefer muzzle-loading to breech-loading as a system, but afterwards you stated, did you not, that you found no inconvenience at all from the machinery of the Armstrong gun?—Yes.

1304. Why then do you prefer muzzle-loading to breech-loading?—It simplifies the gun; there is not that complication about a muzzle-loading gun that there is about a breech-loader.

1305. But I think you stated that you did not find any inconvenience from the complication of it?—Not in the working.

1306. Then what do you find inconvenience from?—In the number of appliances which have to be carried spare for the gun; more gear and more tools.

The witness withdrew.

Adjourned to to-morrow at 11 o'clock.

### Wednesday, 14th January 1863.

PRESENT :

MAJOR-GENERAL RUMLEY, Inspector-General of Infantry.  
COLONEL ORMSBY, R.A.  
COLONEL TAYLOR, R.A., Commandant of School of Gunnery.  
CAPTAIN PREEDY, C.B., R.N.

COLONEL SIMMONS, C.B., R.E.  
COMMANDER SINGER, R.N.  
MAJOR YOUNG, R.A., Director of Artillery Studies.  
JOHN PENN, Esq., F.R.S.  
WILLIAM POLE, Esq., F.R.S.

CAPTAIN DYER, Assistant Inspector of Artillery, Secretary.

MAJOR-GENERAL RANDAL RUMLEY IN THE CHAIR.

Major THOMAS MILWARD, R.A., examined.

1307. (*Chairman.*) You commanded a field battery on service in China, in the year 1860, did you not?—Yes.

1308. Will you state to the Committee your opinion as to the practical working of the Armstrong guns and ammunition?—The guns that we had were Armstrong 12-pounders of 6 cwt.; they were a special gun for the service; two batteries only were constructed of that weight.

1309. (*Col. Ormsby.*) Were they the new 9-pounders?—No; there is a difference in the construction of the breech, and in the exterior shape. We carried 12-pounder ammunition, and they carry only 9-pounder ammunition. We fired the 12-pounder shell, which is now used with the 8-cwt. gun. We had a light gun and a reduced charge.

1310. (*Commander Singer.*) What was the charge of that gun?—1 lb. 6 oz., as well as I recollect.

1311. (*Col. Ormsby.*) Was the range of that gun good?—We found it very good indeed.

1312. What was the greatest range at which it ever came into action?—2,000 yards, with very good effect. On the first occasion we were firing against cavalry, and often firing at 450 yards and 1,200 yards;

we took two shots at 2,000 yards, both of which took effect.

1313. What was the smallest range that you fired at?—450 yards.

1314. How did the shell act then?—Uncommonly well with concussion fuzes.

1315. Did you fire the time fuze with it?—We tried them, but they did not answer. Our time fuzes had all been damaged on the voyage out.

1316. From what cause?—From damp; they were packed in tin cases closed with tape round the joint, and each box was filled with cow hair, and it did not seem to answer; there was some damp about it. I have some rough notes which show that on opening the boxes, even on arriving at Alexandria, before disembarking them, I found the ammunition in the limber boxes damaged; everything in the boxes was covered with green mildew, and when we came to open the fuses, we found that the time fuses were showing signs of rust all through; the concussion fuses were not so bad; but the time fuses were showing a great deal of green mould.

1317. Was the effect of the shell at 450 yards as great as from a common smooth bore case shot?—

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Yes; greater. We found the damaging effect very great indeed. The Tartar horses are great thick horses; at 1,200 yards, we found that the segments had gone completely through them, and left a mark at the off side of the horse, just as if cut out with a knife, as clean as on the near side. At Sing-ho, in action against the Tartars, we fired 18 rounds per gun; we commenced at 1,200 yards, and then reduced it to 450 yards, and afterwards we increased it to 2,000 yards. The shells and concussion fuses (which only were used) acted admirably; nothing could be better than the bursting of the shells.

1318. When you fired those guns with the concussion fuse, what set them off?—Their striking the ground on the first graze; and they generally acted very well.

1319. How much should you say in front of the troops?—From 25 to 50 or 60 yards; 30 yards was the average, perhaps. We find great benefit in the concussion fuses in this way, that you can pick up your range with much greater facility; you can see exactly where the shell bursts.

1320. What sort of ground was it?—It was quite flat on the first occasion. Afterwards, we were firing into works at the Taku forts; on the first occasion we fired a few rounds at 2,000 yards when we could see the shells bursting; we afterwards ascertained that our shells had produced a great effect; in fact, their shots did not reach us and we shut them up.

1321. Was it quick firing?—We only fired five rounds a gun slowly, and there were six guns.

1322. (Major Young.) Did you feel the want of a common shell at any time?—Yes; on one occasion in firing at some junks which it was desirable to set fire to across the river, and which were annoying us, the old 24-pound howitzers were brought up for the purpose; it was a short range, from 400 to 500 yards, and our shells did not carry powder enough. That was done by Colonel Barry's battery, but I was near and saw it.

1323. (Col. Taylor.) And did the common shell set them on fire?—Yes, I believe the common shell set them on fire; a boat got across afterwards, but I think they were blazing before the boat got across.

1324. (Col. Ormsby.) From your experience in China, would you give it as your opinion that it is better to have a shell gun always attached to each battery?—It is decidedly well to have shell guns. We want a shell carrying a large charge of powder in the field. Our present shells are segment shells; we want a common shell.

1325. Would you recommend the Armstrong gun for that purpose, or would you recommend the common 24-pounder?—I see no reason why the 20-pounder Armstrong should not make a very good shell gun for the field.

1326. (Col. Taylor.) You would, of course, like to combine long range with the shell?—Yes.

1327. (Col. Ormsby.) From your experience, which would you recommend if you were ordered to fit out a battery to-morrow and allowed to do it as you like?—I would have the 12-pounder Armstrong for a field gun and the 20-pounder, something like the present boat gun, for a shell gun.

1328. (Major Young.) Would you have them in distinct batteries?—I like distinct batteries for the reason of simplifying the ammunition. With regard to the guns I think the 20-pounder Armstrong would make a very good shell gun for field service.

1329. (Col. Taylor.) In the event of your having to organize the artillery for an expedition, would you or would you not prefer to keep the batteries of Armstrong 12-pounders complete as 12-pounder batteries, and have distinct batteries of shell guns to be applied where required, or would you mix up the calibres in all your batteries?—My own opinion is decidedly in favour of having separate batteries.

1330. (Col. Ormsby.) Do you ever wish to get a longer range than you have with these guns?—We have no occasion for a longer range. Where we were,

in fact, we only fired at 2,000 yards; our guns were sighted up to 3,000 yards, but we never wanted a longer range.

1331. With regard to accuracy, did you find them sufficiently accurate?—Quite sufficiently accurate. We had on two or three occasions to test their accuracy, and we found a very marked difference; having had a great deal of practice with the smooth bores I found that the facility of laying accurately was much greater with the Armstrong, and that it is more regular in the practice.

1332. (Chairman.) Was that attributable to the improved mode of sighting?—I think it was attributable in a great measure to the rifled gun and to the greater regularity of the practice. We had some disadvantages with those guns; the carriages were of very faulty construction. They were not like our present carriages; the carriages were made by the carriage department, but not upon our plans, and they failed; they were very bad, so that the gun was at a disadvantage on such carriages.

1333. (Col. Ormsby.) Had you any firing against earthworks?—Yes, on three occasions we fired against earthworks. The effect of a small charge of powder on the works themselves was trifling; the charge of powder was too small, of course, to produce any effect, but we found the effect inside the works very great, the damaging force of the shell was so great, and it retained its velocity so well. We had been firing at 600 yards' range, and we found marks of the segments on the muzzles of one or two of the guns inside the works.

1334. Were any of the enemy's guns rendered unserviceable by your firing?—That I cannot exactly say. There was one gun that we imagined had been rendered unserviceable, because after one round one of them ceased firing, and we found the carriage a good deal broken, the quoins knocked off it, and the gun pointing up in the air, evidently deserted; but we should not have thought the gun unserviceable if we had been firing with it.

1335. (Major Young.) Still you prevented the men standing at their guns?—Yes; they could not have stood there with that gun, so they left it.

1336. (Col. Taylor.) Have you had occasion at any time to try firing with reduced charges for dropping over works?—No, never.

1337. (Major Young.) In firing in that way directly at the guns of the enemy, how did you manage if you could not use your time fuse?—We always used concussion fuses, because the time fuses were a failure.

1338. How did the segments act if the shell only burst on striking on the embrasure?—We found that the segment shell was useful for firing at the enemy's works for this reason, that in one place, on the top of the parapet, was a smaller parapet, a sort of crenulated wall made of mud, about two feet thick, which was just sufficient to burst the segment shell; the segment shell on striking this little parapet burst and destroyed the people inside. We found at one place called Tong-Ku, the whole gun detachment killed, all hit on the head with the segments; this little crenulation on the top of the parapet having been sufficient just to burst the shell.

1339. (Col. Ormsby.) Did they keep up much of a fire of artillery against you?—Yes; at Tong-Ku it was a very well sustained fire of artillery, and as we got closer, they fired against us bullets and ginal balls, and such kind of things.

1340. Were any of your guns hit?—No; no gun was hit.

1341. (Col. Simmons.) Were those gun detachments which were so much injured, working the guns immediately in the rear of the parapet?—Immediately under cover of the parapet.

1342. Did you try the effect of enfilading the face so as to bust your shells at the commencement of the face that you would try to enfilade?—No; all our fire was direct.



1343. (*Col. Ormsby.*) Do you think that those guns could have knocked over the enemy's guns and dismounted them?—Yes, I think so; of course not the very heavy guns. Ours were only 12-pounder, with 1 lb. 6 oz. of powder, and yet I think they would have knocked over a field gun, striking into it if it was a gun of their weight and size; the Chinese were firing with 60 cwt. guns.

1344. Did the men work your guns easily?—Very easily indeed. I see in my notes also that we found no difficulty in working the guns; that we used the sponge very little.

1345. Had you any lubricating wads?—No, we had no lubricating wads; they were not invented in those days. I may state that we had no difficulty at any time in working the breech-loading apparatus; we only sponged about every ten rounds, and we found everything go very square and well.

1346. (*Commander Singer.*) You used water, did you not?—About every ten rounds we sponged with wet sponges.

1347. (*Major Young.*) Did you have any lubricating wad at all at that time?—None whatever.

1348. (*Commander Singer.*) You found no difficulty in causing the projectile to gain its seat?—No; none.

1349. (*Major Young.*) Did you find the shells too high at all for loading?—No; our shells were not.

1350. (*Commander Singer.*) Were your shells damaged at all?—No.

1351. (*Major Young.*) Had you much knocking about on the roads?—We had not any travelling on hard roads; we had a great deal of knocking about in the limber boxes, and hoisting in and out on board ship. Sailors are very rough handlers of those things, and we had a good deal of knocking about of the ammunition.

1352. Did you go out on board the Peninsular and Oriental Company's steamers?—No; on board transports.

1353. (*Col. Simmons.*) Do you consider that with such destructive effects against gun detachments in the way you have described, within parapets, it would be unnecessary to establish ricochet batteries in a siege?—No; I do not think so. It was only under peculiar circumstances that our shells happened to penetrate the top of the parapet and burst there. If we had had the time fuse it would have burst in front of the embrasure, and it would have had the same effect; but, in this instance, the embrasures were very small and we produced the effect by firing at this little crenulated parapet.

1354. If, with the time fuse, it would have such destructive effects, that would tend, to a great extent, to supersede ricochet batteries, because if a gun detachment could not live at the guns it would have the same effect as dismounting guns?—No doubt if you could burst the shells in front of the embrasures they could not live at the guns.

1355. Was this small crenulated wall near the crest of the parapet, or on the front of the parapet?—It was on a sort of superior slope of the parapet.

1356. Would you not produce the same effect by bursting the shell at the crest of the parapet?—Yes; just bursting it on the crest of the parapet, but it would require very accurate practice to hit it; this crenulation was about two feet high.

1357. (*Commander Singer.*) The parapet was low, was it not?—The parapet was up to the men's chests, and this crenulation covered the men's heads; the shell burst upon them and hit them in the head.

1358. In ordinary parapets it would not have had the same effect?—No; with regard to the traversing apparatus I found, when we came to fire in soft ground, that the wheels got imbedded at the first round or two; and we found it a great advantage to be able to fire from the same wheel holes without having to shift the whole carriage; by a turn of the traversing screw we could lay the gun.

1359. (*Col. Simmons.*) Did you have any vent-pieces blow out?—Yes; one which was clearly

traceable to the carelessness of the man who was trusted to screw it up.

1360. Did it do any harm to the gun?—No harm whatever; I find by my rough notes "that on one occasion, owing to improper screwing up of the vent piece, it was blown away, and the metal water spout (which is now done away with) being forced down on the traversing screw, bent it and the metal socket in which the female screw is placed, rendering the traversing apparatus unserviceable. This did not in any way affect the use of the gun, and, indeed, I think it worthy of consideration whether the traversing is required at all for field purposes." That was the first day that we used the gun. But afterwards all our firing being on soft ground we rather changed our opinion about it.

1361. (*Mr. Pole.*) Was that one vent piece blowing away the only accident of that kind that happened to you?—Yes; that was the only accident that happened to the gun at all. With regard to the rapidity of firing, I may state that we fired on one occasion 85 rounds a gun in something under three hours, which was nothing very particular.

1362. (*Commander Singer.*) You might have fired quicker might you not?—We might have fired a good deal quicker if we liked.

1363. You look upon that rapidity of firing of the Armstrong gun as sufficiently great?—Yes; we look upon it that we can fire quite as rapidly as with the old gun.

1364. (*Col. Ormsby.*) What is your opinion with regard to its capacity for firing different kinds of projectiles?—We were only supplied with one kind of projectile, but we found very great benefit in having only one kind of ammunition in the battery, which was available for different purposes. We found that in replenishing our ammunition in the field, for instance, we had simply to bring up any limber or any waggon and empty it into the one that we were using, and whenever you put your hand into the limber box, whatever you wanted was at hand.

1365. Had your guns much rough work?—Mine had on one occasion very rough work indeed. We were sent out with a division of the army over a swamp, the very worst ground possible for artillery; the guns were in fact almost swallowed up, but we got them through quite safely, and when we came into action no damage was done. Everything was covered with mud, but as soon as we had cleaned that off the guns were just as good as ever. The breech-screw was completely hidden, nothing can hurt it, and no mud could damage it because it was so completely covered in the breech of the gun.

1366. It did not take long to get it to rights, did it, after you got out of the mud?—Only a few minutes; all the sights were clogged with mud, and the gun was completely covered with it; the horses had to be taken out of some of the guns, which had to be dragged by main force.

1367. Were the sights on the gun at the time?—Yes, all the sights were on the gun and everything ready for action, and they were not damaged at all. I may say, at the same time, that we did not like our sights, they have been altered since, they were not the same sights as are now in the service.

1368. (*Col. Simmons.*) Were all your guns plugged on board ship for transmission?—They were packed in wooden cases and covered with a composition of white lead and tallow until we disembarked at Hong Kong; after that they were taken out of the cases and completely cleaned, and then no more composition was put on them, or cases of any kind; they were generally kept mounted in the hold of the ship, and they were embarked and disembarked in rough weather, and no damage ever received to them of any description. We disembarked the guns at Talien Whan with the whole army. We landed several of them in our ship's boats on a temporary apparatus which we put up ourselves, and in rough weather, but nothing occurred to them.

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1369. (*Mr. Pole.*) Is it white-lead and tallow which is generally used for packing guns?—That was a composition made up by Sir William Armstrong, and which is usually put upon machinery to preserve it from rust.

1370. (*Col. Ormsby.*) Did any of your guns give way after firing a number of rounds; was there any drooping of the muzzle or anything of that sort?—No.

1371. Have you any record to show how many rounds a particular gun had fired?—There was such a record with the battery, but I have not it in my possession.

1372. There was nothing very extraordinary in the number of rounds fired?—No, we only fired about 200 rounds per gun during the whole time. We never came on our reserves of ammunition; we never emptied both lines of waggons, and consequently we had none of the inconveniences which would have arisen if we had had to bring up ammunition in boxes.

1373. Do you think that the breech-loading system is too complicated, or have you ever found any inconvenience from that cause?—No, I do not think I ever found any inconvenience. It is not of so simple a construction as the muzzle-loader, and it requires high training in the men; any system of breech-loading will require steady gunners and highly trained men.

1374. What do you mean by high training in the men?—We must have the utmost steadiness of drill to keep the men steady at breech-loading under fire, much more so than in muzzle-loading. There is something to go wrong in breech-loading, whereas there is nothing to go wrong in muzzle-loading. We must have our men very highly trained; we want the best class of men to work breech-loaders under fire.

1375. (*Col. Simmons.*) You have had scarcely any experience of loading under fire, have you?—Yes we have.

1376. Were you within range of the Chinese guns?—Yes.

1377. (*Col. Taylor.*) Did you find the men get flurried or hurried in handling the breech-loading apparatus at all?—No, I did not, the fire that was on us was not sufficiently heavy to flurry the men much.

1378. Did you lose any men?—We had three or four men wounded and an officer, but they were not falling all round. The men were quite cool and collected throughout; in fact it was rather good fun for them than otherwise; they rather liked it, and they were as steady as possible, nothing went astray; but at the same time I think if we had been under very heavy fire, perhaps the men would not have been quite as steady at breech-loading as at muzzle-loading; but I think all that is counterbalanced by the advantage gained by the rifled gun. If we could retain the advantages which we have gained by the Armstrong gun, and combine them with the muzzle-loading system, I should prefer it.

1379. (*Col. Ormsby.*) If you had two equal guns in point of range you would prefer the muzzle-loader to the breech-loader?—If they were equal in every respect, and if we could attain the advantages of the Armstrong rifle gun with a muzzle-loader, I would prefer it.

1380. (*Col. Simmons.*) Would you not think it still more preferable to have the advantages of both combined, so that if a shot by accident stuck in passing down the bore of a muzzle-loader you might remove the breech and draw it out again?—Yes, if it stuck there so tight that you could never force it out by any other means, but I think it would be questionable to adopt the breech-loading for such a reason as that alone, a small charge of powder would generally remove it.

1381. (*Col. Taylor.*) During the time that you were crossing this very bad muddy ground, did you have any instance of a gun being upset in the mud?—Not turned completely over.

1382. Not so that the gun itself became filled with mud?—No, not so much as that; the gun was covered with mud, but not filled with it.

1383. (*Commander Singer.*) I have heard that in that battery which you commanded the lead stripped a good deal from the shell, and you could not fire over the heads of your men, was that the case?—I do not think it was the case, standing with the battery of course I had not so much means of observation as the men over whose heads we might be firing, but there was a story abroad of a man in an infantry regiment having been killed by one of the shells passing over his head; but there was no proof whatever of that, and I am firmly under the impression that it was a mistake. It was one of my guns I believe; we were firing over the troops a considerable part of the time.

1384. (*Col. Ormsby.*) At what distance were the troops from the muzzles of your guns?—About 600 yards at least, but the story was that a shell burst in its flight. Now we were firing concussion fuses, and I think it is very unlikely that they burst at 700 yards in their flight without hitting anyone; it is, I think, almost impossible. I believe the story originated in the fact of a man being hit on the back of the head, and it was said that he must have been hit from behind. I do not think that follows at all. The men were lying waiting for orders to advance, and the man might have been just as well looking round and have been from the front as from behind.

1385. (*Col. Simmons.*) In fact you have had nothing to shake your confidence in firing over your men, if necessary?—Not as far as I saw.

1386. (*Major Young.*) Have you found your shells burst in the gun at all?—Only one, that I saw, and that was in ramming home, and it was traceable to one of the damaged fuses. Our concussion fuses were damaged, and I had them all taken to pieces and repaired, but they were not very trustworthy.

1387. Was the gun injured on that occasion?—No, not at all; the shell burst in the act of ramming home, and we got a log of wood and drove it back, and there was no injury at all; the charge was so small that it did not do any harm.

1388. (*Col. Ormsby.*) Was any damage done to the man loading the gun?—No; the sponge was driven out of his hand, but he was not hurt.

1389. (*Col. Simmons.*) Was it a cylindrical cased shell that burst?—No.

1390. (*Col. Ormsby.*) You state that your concussion fuses were very much damaged in the transit, and you took them to pieces and repaired them; were they easily repaired?—There was no difficulty about it; we did it on board ship. We had special artificers with us; each battery had a civil artificer, and we put him to work to repair the fuses, but I do not think it was necessary to have him.

1391. From any thing that you have seen, do you think that your own gunner is sufficient?—Nothing happened to us that I could not have repaired myself if the civil artificer had not been there.

1392. (*Col. Simmons.*) Had you to place fresh bouching on the vent pieces at all?—No, we faced them once; but then we only fired 200 rounds.

1393. (*Col. Ormsby.*) Do you think that the calibre of those guns is quite sufficient, or would you have it larger?—I think that for field purposes the larger the calibre the better.

1394. Do you think the calibre of the 12-pounder too small?—I would not have it smaller, I would prefer it larger, if anything.

1395. Would you propose to have a larger calibre and a shorter shot?—Yes, if it could be done with the same weight of gun; I would not like to increase the weight of the gun.

1396. (*Commander Singer.*) You would not like to decrease the range either, would you?—No.

1397. (*Col. Taylor.*) You would not sacrifice accuracy for the sake of getting a larger diameter?—No; I may observe that when our time fuses were found bad, we broke in on the store and got some others. I find by my notes on the 17th of July 1860, I say "Being anxious to try the new time fuses, I got Hay to come out this morning to try a few



"of them; I should say that after practice last day I looked for the cause of the non-explosion of the concussion fuses." We had fired several out of our limber boxes and they had not exploded, and I tried to find out the cause of it. This was before we came into action, before we went up the Peiho. "I imagined it might be that the wad was too thick." There is a hole at the top of the fuse, and there is a wad just like the common wad of a fowling piece, to prevent the powder coming out of the hole. This was one of the green wads that you use in shooting, it was a very thick one, and I thought, perhaps, so thick that the charge of the fuse did not communicate with the burster. "I imagine it might be that the wad was too thick, so I bored a hole in one of those fired to-day. We fired two time fuses at 800 yards with very good effect." Those two happened to burst well; "two others at 3° 30' did not get elevation enough, as we were firing from a slight height, and having struck the water before their time did not explode. We then fired a concussion fuse, with no hole in the wad at 200 yards; it burst beautifully. Another at 1,500 yards, with a large hole in the wad, did not explode. I came home and pulled two or three to pieces, finding two out of three very rusty inside the hammer," (that is the moveable part of the fuse) "appearing blocked with rust." It was so jammed to the case of the fuse that it could not act. Afterwards when we came to open them we found

that the little charge of powder in the end of the concussion fuse was damaged. This was replaced, and that was the fuse which we used.

1398. (*Col. Ormsby.*) You think that the damage was caused by the damp in transit?—Yes, it was a peculiarly damaging climate in that way.

1399. (*Major Young.*) Did your guns require any repair other than could be effected by the battery armourers?—No, one battery of those guns was brought away from Tien Sing when the army was coming down, and they were placed on board junks at Tien Sing; just laid on the deck of the junks; they had some rough weather, and the salt water got at them and they were rusted very much indeed, and in that case we could very easily understand the cause. I happened to be in Hong Kong when they arrived, some weeks afterwards; they were covered with rust inside and out, and the breech screws were jammed so tight that it took considerable force to remove them. The guns were to be left in the country, and we thought it was best to get them in order. We handed them over to the gunners, who cleaned them up, unscrewed the breech-screws and polished them up with oil; it required only a couple of days to get them into order again, and they were just as good as ever.

1400. (*Mr. Penn.*) Do you experience any inconvenience by dust or sand, or anything of that sort, interfering with the screw?—None whatever.

The witness withdrew.

Captain ARTHUR HARRISON, R.A., examined.

1401. (*Chairman.*) You are secretary to the Iron Plate Committee, are you not?—I am.

1402. Have you witnessed any experiments with the Whitworth guns?—Yes, I have seen all that have taken place against iron plates.

1403. Have you seen any practice with the Whitworth field guns?—I cannot speak with respect to the guns at all, that matter did not come under the attention of the committee. The experiments carried on by the iron plate committee were merely to investigate the advantages of special shot for the penetration of iron plates. The committee have not gone into the question of the guns at all; in fact we have not even paid any attention to their loading, and therefore I cannot speak as to the merits of the guns at all.

1404. Upon what subjects could you afford the Committee any information?—The only information that I could give regarding the Whitworth guns in any way would be in reference to the result which Mr. Whitworth has achieved in the penetration of iron.

1405. Would you be good enough to state that to the Committee?—The first experiment of the sort that we had was in September with Mr. Whitworth's 70-pounder gun; Mr. Whitworth undertook with a 70-pounder shell to penetrate a 4-inch iron plate backed, and for this purpose a box target was made, and at a range of 200 yards Mr. Whitworth penetrated a 4-inch armour plate and 13 inches of wood, and indented a 2-inch plate two to three inches, the shell bursting inside the box; that was the first experiment that we saw.

1406. What was the description of gun?—It was a 70-pounder muzzle-loading rifled gun.

1407. (*Col. Ormsby.*) Rifled according to Mr. Whitworth's plan?—Yes. The same day we had an experiment with the Whitworth breech-loading 12-pounder gun. Mr. Whitworth also undertook to penetrate a 2½-inch unbacked armour plate with solid shot, or a 2-inch backed plate, with his shell from a 12-pounder and to explode his shell after penetration. To test this we fired one round of solid shot at a 2½-inch plate, and the solid shot penetrated it completely; we then fired a round of shell and the shell penetrated, but it was doubtful whether it exploded before or after penetration; another round was there-

fore fired, and it was perfectly evident that the shell did explode after penetration.

1408. Was the 70-pounder a muzzle loader?—Yes.

1409. (*Major Young.*) Was the 12-pounder a brass gun, or of homogeneous metal?—I really cannot say; it was the one that was down at Shoeburyness; it was a very long gun.

1410. Then it was a homogeneous gun?—That might have been so; I cannot say precisely. The next experiments that we had were on the 25th of September, when Mr. Whitworth's 120-pounder muzzle-loading rifled gun was tried for the first time against iron plates; Mr. Whitworth undertook with this gun to penetrate a Warrior target at 600 yards. To test this we fired one solid shot of homogeneous metal; this shot did not penetrate the target, it penetrated as far as the skin and remained in the backing. When the shot was taken out it was very much set up. Mr. Whitworth informed the Committee afterwards that the shot was of very inferior metal to what it ought to have been, and that he would be able to improve it. We fired on the same day a shell of homogeneous metal, weighing 130 lbs. at the same target, and it penetrated the armour plate and burst in passing through the backing. Some portions of the shell, backing, &c. were picked up inside the target; they had made a hole through the skin. The shell itself did not break into very many pieces; about a dozen pieces were picked up. The next experiments which we had with the Whitworth projectiles were on the 13th and 14th November last. I ought to remark that in the first experiments against the Warrior target, the armour plates of the target were considered of very bad quality, and no test comparatively speaking, and therefore a fresh target was made to further test the projectiles, and Mr. Whitworth requested that on this occasion the 120-pounder should be tested at 1,000 yards, and the 70-pounder should be tested at 600 yards; but the 120-pounder was obliged to be fired at 800 yards instead of 1,000, owing to the desired range at Shoeburyness not being able to be used; so that we had the 120-pounder on that day at 800 yards of range. We fired from it on that day two shells of 151 lbs. each, those shells were of larger capacity than the one fired in the pre-

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vious experiment, and were fired with a bursting charge of 5 lbs. The shells both burst in the backing and made a hole in the skin of the ship, but the lateral effect in the interior of the target was not great, although a great many fragments of the shell were forced inside. The target made for the experiment was a box target, in order to enable it to be seen what effect was produced inside, and the lateral effect was evidently not great although there were a great many pieces picked up. The shells broke into about 20 pieces each. A hollow cast-iron shot, weighing 130 lbs., was then fired, but it did no damage at all as far as penetration was concerned; it only broke a rib. A smaller shell weighing 130 lbs., was then fired with a bursting charge of only 3 lbs. 8 oz., instead of 5 lbs., and it penetrated the armour plate, and apparently burst just as it broke the skin. It made a large hole, and a good many fragments were picked up inside. A solid shot was then fired, and it completely penetrated the target, and was picked up resting against the back of the box target. The shot was set up, but it was decidedly a great improvement on the previous shot. It was observed that all the shells exploded before penetrating the skin of the target. The nearest thing to an explosion inside the target, was the last shell which was fired, which exploded, as far as one could judge, just as it penetrated the skin. The same day we had experiments with the 70-pounder at 600 yards. With this gun a shell of 81 lbs. was fired. These shells were also of larger capacity, so as to put in an increased bursting charge, and a shell with 3 lbs. 12 oz. bursting charge penetrated the armour plate, and burst in the backing, but the skin was not penetrated. Another shell was then fired, and did no damage inside of the target; it burst in front of the target. A shell was then fired with a reduced bursting charge of only 2 lbs. 10 oz., and it penetrated the armour plate and 11 inches of the backing, and it burst in the backing. A blind shell was then fired, made of the same metal; it did comparatively no damage, and broke up. Mr. Whitworth said that this last shell was made of very bad metal indeed, when he examined it. On the following day, the 14th of November, we again tried the 12-pounder Whitworth gun, and on this occasion it was fired against a plate at an angle of 45 degrees. Through an error in the projectiles that were being used, we fired two cast-iron solid shot, believing them to have been homogeneous metal. The result on the sloping plate was really nothing at all. In one case the shot made 0·5 of indent, and the other 0·85, and it did no damage at all, and the shot broke up in both cases. The mistake was then found out from looking at a piece of the metal; and two homogeneous solid shot were fired, which penetrated the plate, and made a clean hole in it, and the shot were hardly altered at all in form; the alteration in the shot after they had penetrated was barely perceptible, in fact, so slight was it, that they might have gone through the gun a second time; there was no injury to them at all. The plate penetrated was 2½-inch thick, at an angle of 45 degrees, so that the shot had penetrated very nearly three inches of iron.

1411. (*Major Young.*) What was the form of the end of it?—It was flat-ended. We then fired a blind shell, made of homogeneous metal, at the same plate. I should say that this plate was unbacked, but it was on a wooden frame, and this shell struck where the plate was absolutely backed by the wooden frame; it penetrated the plate completely, and penetrated into the wooden backing, and was itself perfectly uninjured by the blow. One other shot was fired from the 12-pounder Whitworth gun, for comparison with some 12-lb. shot of Sir William Armstrong's. The head of the Whitworth shot was broken off, and the shot made an indent of 1·4 inches on the target; the target was 8½ inches thick, and the experiment was only for the comparison stated above. Of course the shot could not do very much against such a thickness of iron; it was a flat-headed shot. On the 29th of December we again fired a 120-pounder Whitworth gun against

a target of Captain Inglis's, which was of solid iron, composed of 6, 7, and 8-inch planks, backed with a 5-inch, so that it gave us 11, 12, and 13 inches of iron. The range was 200 yards, and the first shot that was fired was a round-ended cast-iron shot, with a charge of 20 lbs. It made an indent on the plate of 1·8 inches, and the shot broke up without doing any further damage to the target. We then fired a flat-ended shot of homogeneous metal with a charge of 25 lbs. This shot made an indent of two inches, and the shot itself broke up into several pieces.

1412. (*Col. Simmons.*) What was the weight of that shot?—The homogeneous metal shot was 130 lbs., and the damage to the back of the target was very slight indeed; there were a few rivet heads broken off. I showed the shot to Mr. Whitworth since the experiment, and having tried it, considers that it is much too hard for the purpose, that it is not tempered sufficiently, he told me; that the shot ought not to have broken up, and ought to have made a much larger indent. Those are all the experiments which we have had with the Whitworth guns.

1413. (*Col. Ormsby.*) Have you seen much practice at iron plates with the Armstrong guns?—Yes, I have during the last year.

1414. What is your opinion with regard to penetration; what system of rifling and of projectile also do you consider to have the greatest penetrating power?—Until the experiments with the Whitworth projectiles, it was considered that the Warrior target, against any one shot, was perfectly invulnerable, and as regarded shell no such thing was thought of as penetrating the target. In point of fact, up to that time we had only seen the Warrior target penetrated by shot from the 300-pounder smooth bore gun: the target had been penetrated by that, but otherwise it was invulnerable, and it was not until the Whitworth experiments that the target was penetrated, but since that time the target has been equally penetrated by shell made by Sir William Armstrong. Therefore, as far as my own individual opinion goes, I believe that it is not the gun, but entirely the metal of which the projectile is made, to which the penetration is due, always, of course, considering that the gun must be able to stand a certain charge of powder; without that, even by using the required description of metal in the projectiles, the penetration of iron clad ships would be hopeless.

1415. (*Col. Simmons.*) Could you give us the details of those experiments in which the plates have been penetrated or perforated by shot from the Armstrong gun in the same manner as you have with regard to the Whitworth gun?—I cannot, because, although we were present, at Sir William Armstrong's request, we were not present officially, and no record of the experiments was kept by our Committee because they were made for Sir William Armstrong's own information, and we were merely present as spectators.

1416. But the projectile did go right through the target, did it not?—Sir William Armstrong has penetrated with a shell into the backing of a Warrior target and blown a hole through the skin of the target.

1417. Do you know from what calibre gun that shell was fired?—A 110-pounder.

1418. (*Mr. Penn.*) And at what range?—At 200 yards.

1419. (*Col. Taylor.*) Do you remember what was the date of that experiment?—No, I do not at this moment. I could tell at the office, but I have not the date with me. Alluding to the 12 lbs. shot fired from Mr. Whitworth's 12-pounder at Mr. Scott Russell's target, for comparison with Sir William Armstrong's shot, two shots were fired from the Armstrong 12-pounder; one flat-ended shot which weighed just over 11 lbs., made an indent on the target of a little over an inch, and the shot was only set up eight-tenths of an inch, and the shot fell back some way. A round-ended shot was fired at the same target and made an indent of 2·1 inch, and the shot was set up very slightly.



1420. (*Col. Simmons.*) Were those two shot from the Armstrong or the Whitworth gun?—Those were shot which Sir William Armstrong had made of metal of his own, fired from his 12-pounder gun, and one homogeneous metal shot was fired from the Whitworth 12-pounder for comparison with them. That was the shot which I alluded to first.

1421. (*Col. Ormsby.*) What was the greatest penetration?—The greatest penetration was that of the round-ended shot from the Armstrong gun, which made a penetration of 2·1 inch, and it was not fractured; the shot was only set up.

1422. Have you formed an opinion as to which has the greatest penetrating power, the Armstrong or the Whitworth gun?—We have only had one set of experiments with the Armstrong gun with anything except cast-iron shot. With the Whitworth gun, on the contrary, we have had no experiments with cast-iron shot except that one shot which I alluded to just now against Captain Inglis's shield. It is the only cast-iron shot that we have ever fired against iron plates from the Whitworth guns, and therefore one could not compare the shot and shell which we have been using with Mr. Whitworth's gun with those which we have been using with the Armstrong gun, because they are of completely different metal.

1423. Which produced the greatest effect, the gun and the projectile which Mr. Whitworth brought forward, or the gun and projectile which Sir William Armstrong brought forward; which had the greatest penetrating force?—Setting aside what I alluded to just now, viz.,—the experiments which I know to have taken place with Sir William Armstrong's gun, though we were not there officially—if I only take the experiments in which the Iron Plate Committee have taken part, we have never had any penetration equal to Mr. Whitworth's.

1424. (*Col. Ormsby.*) From what you have seen of those experiments, do you think that the guns are equal with regard to their penetrating power, supposing you employ the same metal in the projectile?—Quite so, I think; I must except one thing, of course, viz., what I said before as to charge. For instance, with regard to the 110-pounder Armstrong gun, if the vent pieces will not stand such a heavy charge as will give you the velocity you require, then, of course, the gun which will stand such a charge must become the first.

1425. You consider the vent piece of the Armstrong gun not strong enough to fire a sufficient charge for those projectiles to obtain the same penetration?—That I should hardly like to say, because I have not seen those experiments officially and there have been so few as yet with the Armstrong gun that I do not know that eventually this 110-pounder may not stand sufficient to enable it to penetrate iron targets.

1426. Did you see any vent piece break?—We saw one that day, the vent piece of the 110-pounder Armstrong break.

1427. Do you know whether the vent piece was of the new pattern?—No, it was a vent which Sir William Armstrong had made of Swedish iron, but it was not according to the new process.

1428. (*Major Young.*) When the Whitworth shells penetrated the Warrior targets, did you observe whether there was any great destruction to the plate itself besides the hole which it made?—Very little indeed; a clean hole was made through the plate as nearly as possible the diameter of the projectile itself.

1429. (*Col. Simmons.*) In fact it was fairly punched?—Yes, punched in the front part.

1430. (*Commander Singer.*) Were the securing parts or the fastenings of the plates much injured?—Yes, they were injured a good deal.

1431. More so than would probably happen from a solid shot penetrating the plate?—I do not think so; I think that the greatest damage to the fastenings, as

far as one has seen yet, is when you get a very heavy shot banging against the plate.

1432. My question merely referred to a solid shot from the same gun, the 110-pounder?—In that case the damage to the fastenings was very much the same each time, I think, but there was no damage at any great distance.

1433. In fact the exploding of the shell at the back did not appear to damage the fastenings?—No.

1434. (*Col. Simmons.*) Were any of the plates so loosened by these experiments with the 120-pounder that they would have been liable to fall off if they had been on a ship in a heavy rolling sea?—Certainly not; more damage was caused to the backing than to the fastenings.

1435. (*Col. Ormsby.*) Which do you prefer for firing against armour-plated ships, from what you have seen; would you prefer a muzzle-loader or a breech-loader?—I think, as far as my opinion goes, that in comparing the two, the muzzle-loading and the breech-loading gun, there is no doubt that, unless a great improvement can be made in the vent pieces, a muzzle-loading gun must be preferable to a breech-loading gun, because, with the former, you could not have what happened on the occasion that I alluded to, on the occasion of Sir William Armstrong's firing, being a delay of half an hour or more in extracting the vent piece which was damaged out of the breech of this 110-pounder gun, owing to the use of increased charges with a view of penetrating the plate.

1436. In the two instances that you speak of, which had the greatest smashing effect upon those iron plates, the Armstrong gun or the Whitworth gun?—I do not think there was very much difference; they both seemed to penetrate with a punching effect: the damage to the plate was much less.

1437. (*Major Young.*) With regard to penetrating iron plates, do you think that anything was due to the flat head?—My own opinion is, certainly not.

1438. Is it only a question of material?—I think so.

1439. (*Col. Ormsby.*) Is there any difference in those large guns, the one being a 110-pounder and the other a 120-pounder?—Yes, the shot that were fired from the 110-pounder were about 80 lbs. weight, and the shot that were fired from the 120-pounder Whitworth, were about 130 lbs.

1440. Was there any difference in the rapidity of firing; was that tested?—I am not aware; in the Whitworth gun there was no attempt at testing the rapidity of firing at all, it was merely for penetration; I cannot speak with regard to the Armstrong gun; we did not remain throughout the experiments.

1441. (*Col. Taylor.*) There has been no trial of that kind between the two guns?—No.

1442. (*Mr. Pole.*) Was there any fuse used in these experiments?—No; there was no fuse used in any of the shells, either the Armstrong or the Whitworth.

1443. (*Col. Simmons.*) How did the ignition of the bursting charge take place?—In the case of the Armstrong shell it was by the cast-iron head breaking up and being driven into the charge of powder. The question of the ignition of the bursting charge in the Whitworth shells is a matter of dispute among many scientific men, and I should hardly like to give an opinion upon it; it is quite a disputed point what causes the ignition of the bursting charge in the Whitworth shells; but with the Armstrong projectile it is simple. It has a cast-iron head, which breaks on impact, and is driven into the charge. I am not in a position to know how the bursting charge in the Whitworth shells ignited, but it did ignite.

1444. Was the powder in each case put loosely into the shell?—No; it was put into a bag in the case of the Whitworth gun. I am not sure as to how it was done in the case of the Armstrong gun.

The witness withdrew.

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Lieut.-Colonel JOHN DESBOROUGH, R.A., examined.

1445. (*Col. Ormsby.*) Did you command a battery in China?—I commanded a division of artillery attached to the first division of the expeditionary force.

1446. What did it consist of?—A battery of Armstrong's, and a battery of 9-pounders. Colonel Barry's Armstrong battery, and my own battery of smooth bores.

1447. Will you state to the Committee the advantages of the Armstrong over the smooth bore, if any; or the effects of the Armstrong shot and shell which you witnessed?—On the 18th of August we were first engaged. I think there were two batteries of Armstrong's and two of 9-pounders advancing on to a mud fort. As we were, I think, about 500 yards from the fort we were enfiladed across the Peiho by a junk, containing some large Chinese guns. Sir Hope Grant sent a couple of Armstrong guns up to stop the fire from this junk. I was in command of the division on the right flank, and I sent two of Barry's Armstrong guns to the side of the river, with a range of about 400 or 500 yards. I think they fired, perhaps, a dozen rounds at the junk, but did not silence the guns of the junk; and then I suggested that two 24-pounder howitzers of the other battery should be sent to try what they could do. Sir John Campbell was in command of those two howitzers. I think they fired, perhaps, about six rounds, three rounds from each gun, and the magazine of the junk blew up, and the guns were silenced, and then we moved on. The Armstrong fired about a dozen rounds, I think. I am not quite certain; but I know it was only a few rounds from the howitzer before the magazine was blown up, and the guns were silenced.

1448. Is it your opinion, from having seen it in active service, that the Armstrong gun is not a good weapon at a short range?—I certainly think that at a short range it is not (this was only 400 yards). What struck me, also, was that I thought the effect of the 24-pounder shell was very useful on that occasion, and on other occasions too, on account of the bursting charge of the 24-pounder being ten times as much as the other.

1449. In arming a battery for active service would you like either to have part of that battery composed of shell guns, or a shell battery attached to you?—Yes.

1450. Do you think that shell guns upon the Armstrong principle would be serviceable?—Certainly.

1451. Do you think that a shell gun upon the Armstrong principle with breech-loading and rifling is essential?—I could not judge of that. At the same time I prefer a shell with a larger bursting charge than the present Armstrong shell for field service, because we proved the advantages of the 24-pounder shell with a 13 oz. bursting charge.

1452. You do not know the 20-pounder Armstrong?—No; I have not seen it.

1453. (*Col. Simmons.*) Had you any time fuses with those Armstrong guns?—Yes, we had time fuses.

1454. Could you have possibly produced the effect of silencing the fire on board the junks by bursting the shell in front of them so that the segments might have taken effect on the crew?—I should think it was not nearly so certain as the shell from the howitzer.

1455. (*Col. Ormsby.*) What was the greatest range at which you came into action with the Armstrong batteries?—I think throughout that short campaign there were very few long ranges with the Armstrong gun. We went close up to the forts, within 400 or 500 yards, and both the Armstrong's and smooth bores were working at that range. The only time that I saw any long ranges with the Armstrongs were when the Tartar cavalry were retreating, and that was sometimes from 1,500 to 2,000 yards; the smooth bores then were useless and had no effect

at all, but our principal work was at those mud forts at very short ranges.

1456. Have you any objection to the Armstrong gun from what you have seen of it on service?—I am of opinion that it was not sufficiently tried in China, so far as I could judge; in fact, the range only 500 yards and at mud forts, and the roads were remarkably good. The only march that we made was from Pehatang up to Peking, and that was a nearly level country. Certainly it was a cross country, but the ground was hard, and therefore not sufficient to try them. Of course reports were made to me now and then of some things that went wrong in the carriages, but I do not think it was a sufficient trial.

1457. (*Col. Simmons.*) When they were used against the Tartar cavalry at long ranges of 1,500 or 2,000 yards, were the shells very effective?—I think they were considered to be effective; in all those forts that were taken, or where any Tartars were killed, I was constantly hearing the report, "This is the effect of an Armstrong shell," but that was not my opinion; I did not see that it was so of necessity; if anything took place at a short range it was always said to be the effect of an Armstrong shell. Segments of shells were picked up, both of the Armstrong shell and the 24-pounder howitzer shell, and I was always told that it was the effect of the Armstrong shell, but I did not think so myself; this was not proof enough to convince me.

1458. (*Commander Singer.*) You imagined that the effect was greatly exaggerated?—I thought so.

1459. (*Col. Simmons.*) In this case of the 2,000 yards there were no other artillery brought into play?—No.

1460. In that case did you occupy that ground afterwards so as to see whether there were any dead men?—There were casualties, but everyone who was there said that the casualties were not very great.

1461. (*Col. Ormsby.*) Were you ever under a hot fire with the Armstrong guns?—Yes, at the capture of the Taku forts we were for three or four hours under a hot fire.

1462. Do you think that the machinery of the breech-loading was at all effected by the flurry of the men under fire?—I do not think there was any great complaint about it then.

1463. Supposing that you had guns of equal range and equal accuracy, would you prefer a breech-loader or a muzzle-loader?—I think I would prefer a muzzle-loader. The great work that we had to do was attacking the forts, and we were trying to effect a breach, and we had, I think, 18 guns, both smooth bore and Armstrongs, at one point trying to bring down an earthen parapet. This mud line was very strong; it was made of very good mud and straw mixed, and I should say that the 24-pounder howitzer shell was much more useful than the other.

1464. At what distance was it?—It was very close; sometimes we were at from 600 to 300 yards; as near as that, but it was no use, we did not effect a breach.

1465. (*Col. Taylor.*) Did you make a practical breach with the 24-pounder?—No, it was not made with either of them; not by the combined batteries.

1466. You say that you do not know the 20-pounder, but if you had the choice of the 20-pounder, the range of which is very accurate, and the bursting charge of which is 3 oz. more than that of the 24-pounder howitzer, the weight of the guns not being very dissimilar, would you object to the rifled gun for shell purposes?—No, I should prefer it decidedly.

1467. (*Col. Simmons.*) In your experience under fire in loading the guns, did you find that the men made any mistakes in the breech-loading guns, such as not screwing up the vent piece?—Not to my own knowledge.



1468. In the hurry and flurry of action they discharged their duties properly?—I think so, so far as I know.

1469. (*Major Young.*) Were any great complaints made against the system by the officers or non-commissioned officers of the rifle battery?—No.

1470. (*Col. Ormsby.*) Did Colonel Barry report the details to you?—Yes, occasionally; not always; we were detached; it did not necessarily come before me; some of the reports were made direct to the brigade major of the artillery force without necessarily coming to me.

1471. (*Col. Taylor.*) You stated in the early part of your evidence that you did not think, if I understood you rightly, the Armstrong guns good for short ranges. Do you mean that there was any want of accuracy at the short ranges?—Not the least, but some things took place in China which I heard of. On the first regular assault that we made, which was on an entrenched camp, I think some of the 44th regiment were skirmishing in advance, and we came so close that we were firing I think at 300 yards, and the report in the camp was that some of the segments of the shell hurt and annoyed the skirmishers in front.

1472. Were they segments of the shell or fragments of lead?—Segments of the shell; I believe they were firing with time fuses.

1473. (*Col. Ormsby.*) Do you know for a certainty that any man of our own force was wounded by our own guns firing over their heads?—Not for a certainty, except that it was the current report in the

camp that men were in hospital from the effect of wounds received in that way.

1474. You do not know that for certain?—No, I know nothing but what was spoken of by the officers of the regiment.

1475. Do you think it is a defect in the Armstrong field gun, its being 3 inches in diameter calibre instead of  $4\frac{1}{2}$  inches, the calibre of the old gun; do you think it is too small?—I have never considered that question.

1476. Did you see the Armstrong guns roughly used?—No, we were very anxious to see it, but really the ground was not bad ground at all; it was generally very heavy, but it was not rocky, and there were not any ravines that one could not go over in a gallop; still it was generally a very heavy pull; we found that the guns in fact went along very smoothly; I think that for two or three marches we had ten horses in the waggon, and the other six in the gun.

1477. (*Col. Taylor.*) You found the waggons too heavy?—Yes, I believe they were only experimental waggons, and they have been changed since. We were ordered to take a great deal of forage, and we frequently had to take two horses out of the gun and put them into the waggon.

1478. (*Major Young.*) Did you fire rapidly against the enemy on any occasion with the two batteries near each other?—Yes.

1479. Did you observe which appeared to fire quickest, the smooth bore or the rifled gun?—There was no very great difference I think.

The witness withdrew.

Colonel ARTHUR J. TAYLOR, R.A., a Member of the Committee, examined.

1480. (*Col. Ormsby.*) Have you carried on any experiments with the Whitworth field guns?—I have carried on no experiments with the Whitworth gun, with the exception of those that have been directed against the iron plates, and on one occasion when, I believe, Lord Palmerston ordered a trial between the Whitworth and Armstrong field guns as to the rapidity of firing.

1481. Will you give the Committee the information which you possess upon this subject?—The Armstrong gun was the 12-pounder field gun of  $8\frac{1}{2}$  cwt. breech-loader; the Whitworth gun was his 12-pounder, and also a breech-loader. I will put in a report of that day's practice. It was unsatisfactory as regarded the Whitworth gun, from the circumstance of his having at that time made the communication between the tube and the charge too small in consequence of which a number of misfires occurred. There was also a difficulty in withdrawing the metal case of the cartridges, which fitting mechanically, and having very little windage, stuck fast, the consequence of which was that the two guns were contending under unequal circumstances, the one not being complete in its arrangements, and the question of rapidity was decided on that occasion in favour of the Armstrong gun.

1482. (*Col. Simmons.*) Were those two defects such as could be easily remedied?—They have been remedied inasmuch as Mr. Whitworth has since made the communication larger, and invented an instrument for extracting the metal case of the cartridge, which answers completely.

1483. (*Col. Ormsby.*) Was there much difference in the rapidity of firing?—There was on that occasion, but you could hardly say that it was a fair test because the misfires threw him out completely. I can give you the exact details on that occasion. The Whitworth 12-pounder breech-loader fired 19 rounds in 25 minutes; practice very good, but delays occurring from the difficulty of extracting the metal cartridge, and likewise from numerous misfires; the Armstrong 12-pounder on the same occasion fired 20 rounds in  $15\frac{1}{2}$  minutes, making very good practice also.

1484. Are you of opinion that if those defects are remedied as you state they are, the difference of rapidity will be nothing?—Speaking of the breech-loading gun, I think they would be about the same; I should incline to think that the Armstrong would be slightly the quickest loading as a breech-loader, but this breech-loader, I should state, Mr. Whitworth has now given up; but it was as quick as it possibly could be wanted to be.

1485. (*Col. Simmons.*) Have you had any similar experiments as to the rapidity of fire between the Armstrong breech-loader and the Whitworth muzzle-loader?—From what I have seen of the firing of the Whitworth muzzle-loader brass field gun, which is, in fact, the old block, bored after Mr. Whitworth's principle, I think the speed slightly in favour of the muzzle-loader.

1486. (*Col. Ormsby.*) From the whole of the experiments which you have seen at Shoeburyness since you have been there, should you give your preference to the muzzle-loader or the breech-loader for field guns, always taking into consideration the accuracy being the same, but merely looking at the principle of construction?—From what I have seen of breech-loading, although I was not in favour of it when it was introduced, I confess that I am a convert to it. I do not see any disadvantages attending breech-loading to counteract one or two decided advantages which it has. I think that in a rifled gun the breech being open to the rear is an advantage, as it precludes the chance of the gun being stopped in action by the sticking of a shot while ramming home. I think that in the event of your gun being capsized in mud, from an experiment which was tried the other day, you would get the breech-loader into action much quicker than you could the muzzle-loader. In fact, to put the result of all my considerations on the subject into a few words, I think if you could guarantee me the vent piece I ask for nothing more.

1487. From your experience, you think that it is still faulty?—I think that there is an uncertainty about the vent piece, especially with a large gun; but keeping to the field guns, we have had no accidents with the last pattern vent piece that has been

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introduced, and I think that in the great majority of cases of injury to the vent pieces that have occurred, neglect has been at the bottom of them, and a hasty performance of simple duties.

1488. You think that this advantage of cleaning out the gun after its being fouled by upsetting in the dirt, and so forth, quite counterbalances the disadvantage of having so much gear about it?—Yes; adding to that, the fact that you only require the caution of one man to be complete in loading with the breech-loader, and that you have no risk whatever of accident from the neglect of No. 2 in sponging.

1489. You think that that quite counterbalances having more gear about the breech?—I do.

1490. (*Col. Simmons.*) In giving that opinion, do you take into consideration the necessity of occasionally repairing and bouching the vent piece, and carrying about the necessary tools for that purpose, and having skilled artificers for it?—Yes, I consider all that; but, of course, that is a matter upon which every man must form his own opinion. I do not see myself that the amount of additional weight entailed by that is sufficient to counteract the advantages which I attach to the system.

1491. (*Major Young.*) Supposing you turn two guns over into the mud, one a breech-loader on the Armstrong plan, and the other a muzzle-loader, do not you think that there is a possibility of a great quantity of dirt getting into the threads of the screw and different parts of the breech which would be likely to render the gun for a longer time unserviceable than would be the case with a muzzle-loader?—I think that the amount of labour required to cleanse those screws completely, and to bring that gun actually into action again, supposing the emergency a very great one, would be considerably less than would be required to extract all the mud that would get into a muzzle-loader. Within the last month I sanctioned an experiment being made at Shoeburyness of upsetting a 9-pounder breech-loading Armstrong into a ditch filled with thick black mud, into which it disappeared, the gun, carriage, and all; it was so completely embedded in the mud, that it took considerable exertion to get the gun out again, and the gun could have been fired in about two minutes from the time it was taken out.

1492. (*Col. Simmons.*) Have you tried a similar experiment with a smooth bore muzzle-loader?—No, I have not; that experiment was suggested to me by an officer commanding a battery of horse artillery, who wanted to ascertain it for his own information.

1493. Do you consider the damage to which an Armstrong breech-loader would be subject from an enemy's shot a disadvantage as compared with a muzzle-loading gun; for instance, an accident to the lever?—I consider that the contingency of the lever being struck is the only serious objection, because in the event of your side sight being knocked away you are in the same position as with an ordinary field gun; you still have your line of middle sight.

1494. What would be the effect of the shot striking the levers; would that have the effect of twisting the screw and fixing it in the breech, or would it merely carry the lever away?—I should conjecture that a blow striking the levers would probably render the lever unserviceable; you would have to take it off and put on another.

1495. Do you think that it would be liable to wrench the screw at the same time, or would the lever come away from the screw?—I think that the lever or a portion of it would come away from the screw.

1496. Have you had any accident at Shoeburyness that would tend to resolve that question?—No, I think that it would be a very good experiment to try.

1497. Do you think that it would be advantageous that an experiment should be tried of expending a lever by firing at it?—I think it would. From what I have seen of that kind of blow, I think you would have less injury from the shot carrying away the

levers than you would from the blow of a hammer, because the velocity of the blow would be so great that it would not have time to injure the screw much.

1498. (*Col. Ormsby.*) Can you give us your opinion about the different modes of rifling, and which mode of rifling you consider the best, the Whitworth or the Armstrong gun?—My reason for preferring the Armstrong mode of rifling is this: that my own conviction is that a shell bursting in the hexagonal rifling would prevent your ramming the next shell home. I have never seen that happen, and therefore I cannot say that it would be so, but from the impediment to loading that I have seen accrue from a very trifling and scarcely perceptible injury in the interior of a Whitworth gun, I do not think that you could burst a shell in it without putting the gun *hors-de-combat*.

1499. What gun are you speaking of?—It was a 12-pounder.

1500. Will you describe the injury?—The injury was such that with the naked eye we could not see it at first; we had not a mirror, but looking down the bore we could see no reason for it; the shell stuck. I happened to come down at the moment that Captain Alderson was carrying on the practice, and he called my attention to the fact of the shell being stuck and their being unable to extract it. He got a pair of pincers to do this, and examined the bore, and he could just feel that there was a slight abrasion. I did not consider that that could be the reason of the stoppage of the shot, but on being examined by a skilled artificer and that abrasion removed the shot went down perfectly easily.

1501. Would that accident occasion much delay in firing?—It would delay you a quarter of an hour or 20 minutes, even that small amount of injury.

1502. A small injury of that sort could be easily remedied, could it not, by the artificer of the battery?—Yes, I should say it would, but that is far short of what would be the result of the bursting of a shell in it. My own view of the danger of that is so decided that I think that a shell ought to be burst in the hexagonal bore, and the extent to which it stops the projectile going down ascertained.

1503. Has there been no experiment of that kind at Shoeburyness?—No, we have not had any experiment of that kind.

1504. Have you seen any shells burst in the Armstrong guns?—Yes, I have seen many shells burst in the bore, chiefly at experiments, without detriment; that is to say, the bore has been disfigured, but the gun has never been rendered unserviceable so as to stop the firing; you might have gone on firing the whole day afterwards.

1505. (*Mr. Pole.*) Does the following shot clear the groove in that case?—I presume that it does. I presume that from its being soft coated, there is a margin for a considerable abrasion of the rifling. I have no doubt that the shot is more scored in going out, and if you could get it up before it had grazed you would find it marked with the grooves, but still the gun is not thrown out of service by such an accident.

1506. Every succeeding shot would tend to clear away the obstruction further?—I have no doubt that it would. If there was anything serious the matter we should send the gun to Woolwich. I have never detected any deterioration of the accuracy by it.

1507. (*Col. Ormsby.*) Have you seen many experiments carried on with the large Whitworths?—I have seen all the experiments that have been carried on with the large Whitworth, because he had made no large gun till I came to Shoeburyness. I have seen all those experiments with the iron plates.

1508. Do you consider that they have better penetration than the guns of a like nature upon the Armstrong principle?—There is no doubt that the greatest penetration has been attained by a projectile from a Whitworth muzzle-loading gun.

1509. Have you ever seen any difficulty in loading one of those large muzzle-loaders?—No; I have never seen any myself.



1510. Have you seen them fired after any rough usage, or when sand or anything was likely to get into the bore?—No; the number of rounds that we have fired are not sufficient to form any very certain conclusions from; there have been only a few rounds fired at experiments.

1511. (*Col. Simmons.*) Those guns have been fired, have they not, with a much heavier charge than the corresponding Armstrong gun?—They have been fired with very heavy charges, and the penetrations above mentioned have been obtained with projectiles of a totally different material from the Armstrong.

1512. Have corresponding shot been fired with the same charges from the Armstrong gun?—The proportion of the charge to the shot which Mr. Whitworth recognizes is such as I should not consider myself justified in firing in an Armstrong gun. Mr. Whitworth's proportion is one-sixth of the weight of the shot, Sir William Armstrong's is one-eighth.

1513. Why would it not be safe to fire with that charge?—Because the Armstrong gun in proportion to the weight of the shot is not constructed nearly so heavy as the Whitworth. For instance, the Armstrong 110-pounder weighs 81 cwt.; the Whitworth 120-pounder weighs 7 tons.

1514. (*Col. Ormsby.*) Although those guns are called the one a 110-pounder, and the other a 120-pounder, that is not the actual weight of the shot, is it?—The actual weight of the shot varies very much with the metal. That would be the actual weight of the shot in the iron-plates experiments very nearly, except were special material was used.

1515. (*Major Young.*) It depends upon the metal, does it not?—It varies very much with the density of the metal.

1516. (*Col. Simmons.*) Was the calibre of the guns the same?—Yes; seven inches.

1517. In fact, a description of gun by the calibre would be a better description?—Yes; but the Whitworth projectile is much longer than the Armstrong.

1518. (*Col. Ormsby.*) The Armstrong 110-pounder does not weigh anything like 110 lbs. does it?—The solid shot weighs 110 lbs., and the shell 100 lbs., and in the Whitworth the shot was about 123 lbs. of homogeneous metal.

1519. (*Major Young.*) What was the effect of the cast-iron shot from the Whitworth 120-pounder?—The effect of cast-iron shot is wonderfully uniform, the result is always the same. The conoidal head sets up, with a number of concentric circles upon it. The whole of the fibres of the body of the shot glide off the centre and leave a cone, the size of which cone, with similar charges, is almost always identical. That is speaking of the Armstrong gun.

1520. Is that the case with the Whitworth cast-iron shot?—Not having seen so many of those fired, I should be sorry to lay down any exact rule for their breaking up; but the remnant is very much in the form of a cone also, as far as I have seen.

1521. As to the effect on an iron plate, do you know at all what it is, as compared with the homogeneous iron shot?—No; there is nothing by which to compare it with the homogeneous iron shot.

1522. (*Col. Simmons.*) If you were to fire an Armstrong gun with a charge of one-sixth the weight of the shot, do you consider that it would bring an undue strain upon the vent piece of the breech-loading apparatus?—Not only upon the breech-loading apparatus, but also upon the construction of the gun. If you construct a gun for a specific charge, keeping in view the element of economy of weight, you strengthen it up to a certain point; you strengthen it for a certain action of resistance; and if you put a cartridge into that gun which reaches beyond that point, I think you put that gun to an unfair test.

1523. Is the reason why you could not fire it with a heavier charge than one-eighth, that the chamber for the powder is not sufficiently long?—By taking out the wad, you might put a larger charge in; but I think the gun being constructed to carry

a charge of one-eighth, I should hesitate to use it with a larger charge?—It might injure the gun.

1524. Do you think that there would be any danger of bursting the gun; would the metal be strong enough?—No. I think that you might injure the gun without bursting it; it would be very difficult to burst one of those coil guns at all.

1525. (*Col. Ormsby.*) Have you ever seen a Whitworth gun damaged in any respect, with the exception of the one you mentioned?—No.

1526. (*Col. Simmons.*) Were those Whitworth guns, of which you spoke just now, made upon the coil principle, or of homogeneous iron?—All the first, I believe, were made by Mr. Whitworth himself; the last one, the 120-pounder, was made in the gun factories at Woolwich upon the coil principle.

1527. (*Col. Ormsby.*) Does Mr. Whitworth recognize the coil principle?—That is a question which I do not know that I am competent to answer; he availed himself of it, at all events, on that occasion.

1528. (*Mr. Pole.*) The two guns used against the iron plates were made upon the coil principle, were they not?—Yes; there was a 70-pounder also made in the same way upon the coil principle, and a 120-pounder; the 70-pounder was made in the gun factories, and I presume upon the coil principle. I may state that upon the occasion of the experiments when that gun was used, Mr. Whitworth requested me to dismount his own gun, and mount the one that had come from the gun factories.

1529. (*Col. Simmons.*) Did he state his reason?—No, he gave no reason for it. We had fired the other with the same charge that we then used, and we found it a very good gun.

1530. Was the gun upon the coil principle of the same weight as the other one that you dismounted?—I am not prepared to say, but I should think, perhaps, they were very nearly the same weight; they were very nearly identical in form, but I could put in a return of the actual weights of both guns.

1531. (*Col. Ormsby.*) From your experience do you like the construction of the Armstrong gun better than the construction of the Whitworth?—The construction of the Whitworth gun I have no fault to find with because I have never seen one fail. I think, so far as my means of judging go, that the mode of building the Armstrong gun is a sound and reasonable one, and one which I think when understood by the men who have to use it is calculated to give them confidence in the gun, for this reason, that I have never known one of those guns that has not given progressive signs of deterioration when anything has gone wrong. As to the Whitworth gun, I do not know; the Whitworth has answered all that has been required of it so far; the construction of the tube of the Whitworth is a solid forging bored out; that is a matter for manufacturers to speak upon.

1532. In your own experience you have not seen the Whitworth gun give way in any respect?—No.

1533. (*Col. Simmons.*) You have not seen it fired a great number of rounds?—Not a great number.

1534. In fact they have not had a test of sufficient experience to determine their durability?—No, the experiments that have been made, have not been sufficient to form any decisive conclusion from, but I have no fear whatever upon that score, and I think that the Whitworth gun is perfectly safe.

1535. Will you state to the Committee what objections, if any, you have to the Whitworth gun, to the projectile and to the mode of rifling?—I have stated my objections to the mode of rifling as being liable to be obstructed by any accident in the bore. My objection to the form of the projectile is, that Mr. Whitworth using a very long projectile it is extremely difficult to get so effective a shell as you do in a shorter one, and the range of his shell and shot would necessarily differ considerably. I think that the mode that he has proposed, or rather that Colonel Boxer has proposed, for a Shrapnell to replace the segment shell, in its present state is very

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inadequate for the purpose. I do not mean to say that it may not be brought to very great perfection, I can only judge by what I have seen; the targets fired at with that Shrapnell, when brought on shore and laid upon the ground, were a marked contrast to what they would have been if exposed to a similar number of rounds from the corresponding Armstrong gun.

1536. That is with regard to the shell. Now with regard to the solid shot, will you state your opinion?—As a solid shot I have no objection to it, it is a very formidable projectile, no doubt, but I look to one of the great requirements of modern artillery, the facility of adapting to the same gun the different projectiles that are required by the different contingencies of the service. I think that it is a great object to gain that.

1537. Then you think that the Whitworth gun is not adapted to fire anything different from Mr. Whitworth's projectile?—In its present state I do not consider that the shell arrangement of the Whitworth gun is to be compared to that of the Armstrong gun.

1538. (*Col. Simmons.*) Do you think that it would be possible to construct a shell upon the segment principle, and with the same fuses as are used in the Armstrong gun to be fired from the Whitworth bore?—I do not see any impossibility in it; but I can only go by what has actually been under my notice. I have nothing to speak to but that.

1539. (*Major Young.*) Do you think that there would be any advantage in the Whitworth gun making use of a fuse like Sir William Armstrong's, or would it not be better to light it, as we did with our old pattern guns, from the charge of powder in the fuse?—There is this advantage certainly in point of economy, that if the windage of the Whitworth shot allows the ignition of the fuse by the flash of the gun, you are enabled to use a much cheaper fuse, and, therefore, considerably economize your fire.

1540. Are they not more certain from this fact, that they are not so liable to injury by keeping, as the detonating composition is liable to deterioration by climate?—I have seen so great uncertainty in the common service fuse, after being kept a long time, that I do not think the advantage accruing from that worth mentioning.

1541. (*Col. Simmons.*) In order to try the relative advantages of boring, either by the numerous grooves adopted by Sir William Armstrong, or by the hexagonal bore, as recommended by Mr. Whitworth, do not you think that it would be advisable to try both with the same description of shell, so as not to complicate the merits of the guns by mixing up the merits of the projectile with the merits of the bore?—That must be a question to be arranged between the two inventors. Sir William Armstrong has his mode of preparing the segment shell, and I am not prepared to say that it might not be applicable to the other system; but I do not think that it is for me to suggest the transferring to one inventor of the invention of another.

1542. (*Chairman.*) Could you give the Committee a little more information, with regard to the rapidity of firing?—I could give some instances. The question has been asked several times about the comparative rapidity of firing from rifled and smooth bored guns, and I can give from my note book the results of several trials. A 68-pounder of 95 cwt., on a dwarf platform, laid alternately on two targets on an arc of 40°, with elevations of 2° and 3° respectively, fired in the first trial 10 rounds in 15 minutes, and in the second 10 rounds in 11 minutes; and very good practice. The same again on three targets at point blank, 1° and 5°. The first 10 rounds were fired in 11 minutes; the second 10 rounds in 13 minutes; practice very good. The Armstrong 12-pounder fired on one occasion 20 rounds in 15½ minutes, making very good practice. The 12-pounder again fired 50 rounds in 38 minutes 20 seconds; practice very good. The 20-pounder land service, 40 rounds

in 39 minutes, at different targets; very good practice. The 40-pounder fired 50 rounds in 57 minutes and 30 seconds, at different targets; very good practice. The 40-pounder fired 20 rounds in 13 minutes 15 seconds at different targets. Again, 10 rounds in 5 minutes and 15 seconds, 20 rounds in 18 minutes, 10 rounds in 6 minutes 30 seconds, all the above at targets varying from point blank to 5°; practice in all good without exception. For a short period we have fired the 110-pounder at the rate of 3 rounds in 4 minutes, with aim. With a partially trained detachment, we estimate that 10 rounds would be fired in 15 minutes 30 seconds. All those periods represent starting with an unloaded gun. I may mention that the only instance that I have seen of difficulty in loading with the lead covered projectile, was in a very small per-centage during a trial made at Portsmouth recently under a committee, of which I am a member, in which we fired away the whole of the ammunition of two field batteries, 123 rounds each; the largest number of shells that were found so set up by travel as to stick in going in, was six out of 123, and many of the guns had only one or two.

1543. Had they travelled any distance?—I am not prepared to say how long they had travelled, but, in none of those cases did it require more than the work of a minute or so with a hammer to make the shell go in with ease.

1544. (*Col. Simmons.*) Was that 123 rounds per gun or per battery?—Per gun.

1545. (*Chairman.*) Had you any opportunity of testing their liability to deteriorate by damp or immersion in water?—I have found the old pattern time fuse certainly deteriorate considerably since I first took the command at Shoeburyness. The practice at that time with that fuse was as nearly perfect as anything could be, and the failures were very rare indeed. Such has not been the case during the past year; the burning of those fuses has become very irregular, and the examination of them has shown that the interior has been injured by various causes, by damp, or perhaps by chemical action within, I am not prepared to say positively which. Those objections, as far as they can be identified, have been met in the recently-furnished fuse, which is the present service pattern, and as far as I can judge, I do not think that there are the same elements of deterioration in that fuse that we have detected in the others, more than that I am not prepared to say, its action is very regular and good now.

1546. Are the projectiles or their parts liable to injury by rough usage?—The lead covered projectile would be so far liable to injury by rough usage that if it was thrown down upon a ragged surface which considerably bruised its exterior you would be unable to load it without reducing the irregularities of the surface; but in the two and a half years that I have been at Shoeburyness, and with the shot not treated particularly tenderly, it being handed about from one battery to another, and put upon the ground, and sometimes knocked down, I cannot remember having seen any instance of a shot that we could not load from that cause.

1547. Have you witnessed much practice against earthworks or masonry?—We had some experiments against earthworks, and we found that the action of the rifled shot, on striking the earth, so far differs from that of round shot that the course is continuously to the right, invariably so if the rifling is to the right. This rule has held good to such an extent that, in removing a large mass of concrete which had been erected for an experiment some three years ago, and into which had been fired a number of experimental fuses which failed to act; on our digging it away to make room for a new target lately we found that the whole of the shells had reversed their position in the concrete, and were pointing in the direction from which they had been fired.

1548. (*Col. Simmons.*) Have you found the same thing in earthwork?—The same thing holds good in



earthwork, but we have not fired Whitworth guns to any extent into earthworks. I could not put my finger upon any trial of Whitworth guns into earthworks furnishing data of any value.

1549. (*Chairman.*) Have you had any experiments against masonry?—No; but I could give you the details of the penetration which took place at a trial against the fort at Eastbourne. At Eastbourne a 40-pounder Armstrong solid shot, weighing 41 lbs., with a charge of 5 lbs., penetrated old masonry from 47 to 65 inches at 1,032 yards distance.

1550. (*Col. Simmons.*) Was that brickwork or stone?—I believe most of those Martello towers are stone and rubble masonry. An 80-pounder solid shot weighing 80 lbs., with a charge of 10 lbs., penetrated from 51 to 90 inches. A 7-inch Armstrong howitzer, with a plugged shell of 104 lbs., and a charge of 9 lbs., penetrated from 38 to 51 inches.

1551. Could you furnish the Committee with tables containing the ranges, initial velocities, and so on, of the different guns concerning which the Committee are sitting here to ascertain the facts?—They can all be seen in a tabular form in the Report on Ordnance of the 25th July 1862. The tables with respect to ranges are from page 155 to page 177, and the initial velocities are at page 267 of the same book. With respect to the retardation that may be deduced from those tables, there is a very careful calculation made by Mr. Noble upon that subject. With regard to accuracy, the plate at page 167 represents the parallelogram of error of guns of all kinds. With regard to penetration, I can get the Committee a table of the penetration into wood, as we tried it with the small guns, not with the large guns. We have not had any experiment with regard to penetration on a very large scale.

1552. Can you give us any instances as to the capability of bearing continued firing with the maximum charge adapted to the gun?—We have instances of guns which have been in constant work, and which have fired considerably over 3,000 rounds, and they are to all intents and purposes quite serviceable. I could give the Committee an idea of the amount of firing which takes place under ordinary circumstances at Shoeburyness; during the quarter ending the 30th of June 1862, there were fired for instructional purposes by the School of Gunnery 2,701 rounds; by the Ordnance Select Committee 1,450 rounds; by the Committee on Iron Plates 157 rounds; by Sir William Armstrong, in preliminary experiments, 91 rounds; by Colonel Boxer, 7. Those were fired with all descriptions of Armstrong guns; that is about a fair average of the amount of firing per quarter. I could put in a complete detail of the whole of the experiments with the Whitworth gun if required.

1553. What is the greatest number of rounds which you have known fired from an Armstrong gun of any calibre since its first manufacture?—I could not answer that question precisely, but I think that we have a gun now at Shoeburyness which has fired about 3,600 rounds, and it is still sound.

1554. (*Chairman.*) Have you had any serious accidents occur?—I have not had a single accident occur in the two and a half years that I have been there of injury from the gun.

1555. Nor a serious accident to the gun?—None beyond the breaking of the vent piece, if I except the bursting of the smooth bore 150-pounder gun, which did not take place until that gun had been tested with more than double the charge for which it was intended, being intended to bear a service charge when rifled of 40 lbs., it was as a smooth bored gun fired with 50 lbs., 60 lbs., 70 lbs., 80 lbs., and 90 lbs., and as an illustration of the security involved in that mode of construction, I would mention that I myself discovered a flaw in that gun by looking in with a mirror after it had been fired with a 70 lb. charge; that an impression was taken of the injury in gutta percha; that the gun was then fired with an 80 lbs. and with a 90 lbs. charge; and that fresh impressions were taken and no material increase

in the flaw was observed. We then in carrying out the experiment went back to the charge of 50 lbs. which brought the spherical shot in the rear of the former injury, and the action of that spherical shot upon the coiled gun was very nearly to obliterate that flaw, and subsequent impressions taken in gutta percha show a marked decrease of the injury as compared with its former state. The gun subsequently burst, and I have no doubt myself that the integrity of the gun was to a certain extent destroyed by the extravagant charges which had been put into it for testing purposes.

1556. (*Chairman.*) At what charge did it burst?—It burst with a 50 lb. charge, but previous to coming back to that we had subjected this carefully and scientifically constructed machine of resistance to a test which it was never constructed for, you brought the force of the explosion to a point which it had not really strength to resist.

1557. (*Mr. Pole.*) Was there not a defect in the construction of the gun in regard to a small hole which you said had been drilled into the rear of the breech chamber?—A safety escape was intended to have been drilled to a certain point where relief to escaping gas would be given, but the workmen having neglected to do so before the gun was closed did it by calculation afterwards in spite, I believe, of Sir William Armstrong's remonstrance, but they failed in striking the point with that exactness which would make this valve any relief whatever to the gun.

1558. And the consequence was that a great deal more pressure was thrown upon that part of the gun than was intended?—Yes, more pressure was thrown upon that part of the gun than was intended, or than would have been thrown upon it if that safety valve had acted.

1559. (*Mr. Pole.*) When the 150-pounder smooth bore gun burst it did no injury to any one, did it?—No; it was fired under the usual conditions of experiments, namely, that of putting the men in security.

1560. And it delivered its shot well at the target; I think at the same time?—It delivered its shot at the target and it struck me at the time, and of that I have no doubt, that a portion of the force which would have been transferred to the shot was expended in throwing off the heavy breech to a distance of about 25 or 30 yards in the rear.

1561. (*Col. Ormsby.*) Was that the only breech you ever saw blown out?—Yes; this was a smooth bore gun then; it was not rifled; it was a muzzle-loading smooth bore which was intended to be rifled, and it was tried as a smooth bore first. We have another gun of the same calibre rifled as a 300-pounder.

1562. (*Col. Simmons.*) Have you fired any shells filled with molten iron, from an Armstrong or Whitworth gun?—We have from the Armstrong gun. Mr. Whitworth has never sent any yet.

1563. Does it answer well?—The first molten iron shells that were fired from the Armstrong gun were too strong, and did not break up properly. Sir William Armstrong subsequently made a fresh batch, which were sent down, and which we fired without any difficulty. The effect of them was not very great. To tell you the truth, I have never seen any very great effect from the molten iron shell.

1564. Still you had no difficulty in serving the gun?—None whatever.

1565. Notwithstanding the soft coating?—No. I could not state the exact time that was allowed without referring to documents, but it required many minutes for that shell to heat enough for the lead to alter its appearance to the eye, and still more for it to come off. Some of those which fell, and did not break up, lay on the ground for a long time, and one could touch them for many minutes after being fired, and by constantly pouring a little water over them, I believe you might keep them for 10 minutes before loading.

1566. (*Col. Ormsby.*) Have you seen any of the lead of the Armstrong shots strip off?—The old

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shots of the first pattern used to strip off a good deal. Then the mode was adopted of fastening on the lead by undercoating, and since then another mode has been adopted of fixing it on with zinc, and still more recently with an alloy of antimony. I examined a few days ago, before leaving Shoeburyness, a large pile of shot which had been brought in off the sands, and that had been fired, and there was no stripping whatever perceptible in any of those of the last pattern. In the old shot, the shot of two years ago, the lead used to strip off, no doubt, but I think that the danger from that to the troops was one that was very much exaggerated; for this reason, that the fragments of lead that were torn off in that way, left the muzzle of the gun under totally different conditions from the lead blown away by the explosion of the shell. They were dragged

off the shell, and the reason why they were stripped off was, that their hold upon the shot was not strong enough to resist the friction in going through, and portions of them were driven off, therefore they left the gun under two conflicting influences, namely, that of retardation by friction, and the action of the explosion, and I never could trace their flight above 100 yards, and then with slow velocity.

1567. (*Col. Simmons.*) Those fragments which you have seen are very small, are they not?—Very small.

1568. Are they an ounce weight, or anything of that sort?—I could not say whether I have not seen them an ounce or an ounce and a half in weight, but they were very small indeed. They were so small, that if you saw them splash on the water at high tide, you would have great difficulty in identifying and picking them up off the sand when the tide receded.

The witness withdrew.

Adjourned to Monday next.

Monday, 26th January 1863.

PRESENT :

MAJOR-GENERAL RUMLEY, Inspector-General of Infantry.

COLONEL ORMSBY, R.A.

COLONEL TAYLOR, R.A., Commandant of the School of Gunnery.

CAPTAIN PREEDY, C.B., R.N.

COLONEL SIMMONS, C.B., R.E.

COMMANDER SINGER, R.N.

MAJOR YOUNG, R.A., Director of Artillery Studies.

WILLIAM POLE, Esq., F.R.S.

SECRETARY :—CAPTAIN DYER, R.A., Assistant Inspector of Artillery.

MAJOR-GENERAL RANDAL RUMLEY IN THE CHAIR.

Lieut.-Colonel EDWARD MORIER BOXER, R.A., examined.

Lieut.-Col.  
E. M. Boxer,  
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1569. (*Chairman.*) The Committee has been appointed to examine and report upon certain facts with regard to the fitness of the guns and ammunition, proposed by Sir William Armstrong and Mr. Whitworth for the various purposes to which ordnance may be applied; namely, for land service, field guns, garrison guns, siege guns, heavy guns for coast defences; for the sea service, broadside guns, pivot guns, boat guns, guns for cupolas, guns applicable to both services, and guns for iron plates. Would you kindly favour the Committee with the result of your observations upon those facts?—The experiments that I have made with the Armstrong gun have had almost entire reference to the proof of the ammunition, and were carried on chiefly with the 12-pounder gun. I have also witnessed a number of experiments at Shoeburyness with other natures of guns.

1570. First of all, will you state what is your opinion of them with regard to range?—I have never made any experiments with a view to determine the range of the 12-pounder gun; my experiments were connected with the proof of the ammunition. With the Whitworth gun I have made a few experiments, to determine the best form of shrapnel shell for the 12-pounder gun, and from these trials it would certainly appear that Mr. Whitworth has succeeded in giving a very good form to his projectile. I have found that if the shell be made in the same form as the Armstrong shell, that is, parallel in the body part of it, at ten degrees of elevation, 500 yards less range is obtained than with the deep taper rear, both being fired on the same day, under the same circumstances, and with the same charge. The deflection also is very much greater with the parallel body than with the taper body. I think there was as much as 24 yards deflection in the case of the parallel body, the range being 3,300 yards, and with the taper body it was about 8 or 9 yards, at a range of 3,800 yards. Both range and deflection seemed to be affected very much by the form of the rear part of the projectile, very much more than I should have anticipated. I also observed that the noise made in passing through the air was very different in the two projectiles; the

one with the taper base appeared to go very much more smoothly than the one with the parallel base; but the experiments were not sufficiently extensive to enable me to give a decided opinion on this point.

1571. Have those experiments been recently made?—Very recently, only a few weeks ago; and I am led to believe that the form which Mr. Whitworth has adopted will certainly give a greater range, and less deflection than the form adopted by Sir W. Armstrong.

1572. (*Col. Simmons.*) Were your experiments made with the 12-pounder?—Yes.

1573. (*Col. Ormsby.*) Was that 12-pounder a brass 12-pounder rifled according to Mr. Whitworth's plan, or was it of homogeneous metal?—It was an ordinary brass gun, rifled according to his plan. I do not think that it is the form of gun that Mr. Whitworth would adopt; the length of bore is not sufficient, it was the old 9-pounder block, which is very short for a rifled gun.

1574. Is the form of projectile good; is the shell of the same form as the shot?—Yes, exactly the same as the ordinary shell, not the steel shell, I think. I think the steel shell is nearly parallel.

1575. Have you seen much practice with the Whitworth shell?—I have fired altogether, perhaps, 400 rounds from the commencement. I commenced to make experiments with the gun to determine the best construction for the shrapnel shell. Mr. Whitworth was anxious that I should turn my attention to this matter, and he applied to the Secretary of State, who requested me to assist Mr. Whitworth, and all my experiments with the gun have been connected with that particular shell.

1576. Was it satisfactory as a shrapnel shell?—Very satisfactory; nothing could have been more satisfactory than the result of the experiments with the shell, so far as the construction is concerned.

1577. (*Chairman.*) Are the results of the experiments recorded?—Yes; when we commenced there were a good many failures. We had gradually to find our way to the most suitable arrangement, but I think that we have now arrived at a very good construction of shell; of course the same interior



construction could be applied to any other rifled shell; it is not peculiar to the Whitworth; the exterior form is more peculiar to the Whitworth system.

1578. (*Col. Ormsby.*) Have you found the windage sufficient to ignite the fuses?—Yes; we used the ordinary service fuses; we have had very few failures indeed from the fuse not lighting. I find even that it will light with a lubricator; almost all my experiments have been made without the lubricator, because I fancied that the lubricator would prevent the flame from passing to the front part so as to ignite the fuse; but I find that even with the lubricator the fuse almost always lights.

1579. Is it not necessary with the Whitworth rifling to use the lubricator in order to keep the shot from sticking?—Not at all; 100 rounds were fired at Shorncliff the other day, and no lubricator was used; almost the whole of my experiments have been made without lubricators. I consider that if a gun of that sort requires any large amount of lubrication it is a very considerable defect in the system, and therefore I have endeavoured to dispense with a lubricator.

1580. (*Col. Simmons.*) In speaking of these 100 rounds being fired, do you remember in what time they were fired?—

1581. Was it as rapid as possible?—There was a little delay at one time.

1582. (*Col. Ormsby.*) Do you think they fired 20 rounds as fast as possible?—They fired as rapidly as possible; after a certain delay, they fired 60 or 70 rounds as quickly as possible. I was present at the experiment.

1583. (*Col. Simmons.*) Was not the Armstrong gun fired at the same time, in order to compare the two?—No, I think not. I do not think any direct comparison was made. The two guns were certainly not placed under similar circumstances for rapidity of fire, because the arrangement for directing the gun was different in the Armstrong to what it was in the Whitworth, and besides the Whitworth was a much heavier gun than was necessary; therefore the circumstances were not the same, and you could hardly make a fair comparison between the two under these circumstances as to rapidity of fire.

1584. In those guns it was an application of the Whitworth principle to the old existing brass gun, and not a gun specially made by Mr. Whitworth?—It was specially made because the bore was less than that of the 9-pounder. It was the 9-pounder block bored and rifled to suit the Whitworth system of ordnance; it was not an existing gun; it had to be cast. The bore of the ordinary 9-pounder is too large in diameter for the Whitworth 12-pounder.

1585. (*Col. Ormsby.*) Do you think that the 12-pounder Whitworth gun would be sufficiently good in firing both case shot and shrapnel from a field battery. Would it be sufficient to have a Whitworth 12-pounder gun without a shell battery?—No. I am a great advocate for a battery of shell guns. The bursting charge is very small in the 12-pounder, being only a few ounces, and I think that charge would be of very little use. It certainly need not be the only gun; there might be a separate battery of large bore guns; I think a gun of large calibre is required for shells.

1586. Would you recommend shell guns to be attached to Whitworth batteries?—Yes; either attached or in separate batteries.

1587. (*Col. Simmons.*) Would you recommend the same thing with regard to the Armstrong gun?—Yes; there is no difference in that respect.

1588. (*Col. Ormsby.*) Does not the segment shell of Sir William Armstrong do away with that necessity?—No, the segment shell is in fact a shrapnel shell; it only contains a very small bursting charge, not sufficient to do any damage as a mine. It is sufficient to open the shell. The less force there is to disperse the pieces, the better.

1589. (*Mr. Pole.*) Will you describe more accurately the shape of the shot which you say was par-

ticularly favourable?—I have brought up drawings of the two shells. This (*exhibiting a drawing*) was a parallel-based one, and that (*exhibiting another drawing*) was the taper base. (*The witness explained the drawings to the Committee.*)

1590. (*Col. Ormsby.*) Would the shell and shot be of the same length?—The shot would not be of the same length; it would be shorter.

1591. (*Col. Simmons.*) With respect to the shell in the drawing which is before me, is it intended to burst the shell in order to free the shot that are within it?—It is intended either to burst or to fire out its contents. If the range were long, then I should very much prefer a charge only just sufficient to blow off the head and blow out the contents, so as to allow the body of the shell to go on whole; by that arrangement you prevent the bullets from dispersing so much as when you break the shell in pieces. But for short ranges I think it better to break the shell.

1592. Will that arrangement permit of your altering the bursting charge?—If you fill the chamber full it will break the shell into comparatively small pieces. If you fill it half full, it will in general merely knock off the head and expel the contents.

1593. Would not it be a very great inconvenience in service in the field to be compelled, according to the particular application of the shell, to increase or diminish the bursting charge within the shell?—You may adopt either plan, whichever is liked best. It is not necessary that you should have two charges; it is only advantageous, at long ranges, to have a shell with a small bursting charge.

1594. If you had a battery in the field, would you have your ammunition made up for the purpose of expelling the shot, or of bursting the shell?—For expelling the shot.

1595. (*Major Young.*) Would the bullets spread at short ranges if you expelled them?—Yes; the rotation being so rapid, the great point is to keep the bullets together as much as possible, and we find that the spread of the bullets is quite sufficient when they are merely expelled. The principal reason why I prefer firing out the contents, rather than breaking the shell, is because in the former case the contents will be effective at a greater distance from where the fuse acts than in the latter case. When the bullets are distributed very much, you must burst the shell very close to the object in order to make it effective.

1596. (*Col. Simmons.*) What is the charge of powder which you place in this shell as a bursting charge, with reference to the weight of the projectiles within the shell?—Very small indeed; I think it is about 8 drachms.

1597. Merely enough to expel the shot, and then for them to proceed with the velocity which they have already acquired when forming part of the shell?—Yes, we find that the shell goes on as a shot afterwards; and it makes a round hole through the target. It is very slightly retarded.

1598. The interior is filled up partly with bullets and partly with segment, is it not?—In the 12-pounder there are a few segments in front; but in all the other natures they are all bullets.

1599. What are the number of particles expelled in the case of the 12-pounder?—There are 40 bullets, and about ten segments.

1600. Are they leaden bullets?—Lead and anti-mony; hard bullets. Of course the contents may be segments or bullets, but I prefer the bullet to the segment; first, on account of its form; and secondly, I prefer lead to iron.

1601. You spoke of the fuse which you applied to that shell as the old service pattern fuse; which do you allude to; the old wooden fuse?—The fuse which has been in the service now for about 10 years; it is called Boxer's fuse.

1602. (*Col. Ormsby.*) Could you, if necessary burst those shells within 20 yards of the muzzle?—Yes, that can be done. I was the first to propose the use of shells instead of case-shot in that way many

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years ago, by bursting the shell close to the muzzle. About half a tenth of meal powder in the fuse would be sufficient for bursting the shell just as it comes out of the gun.

1603. From what you have seen do you think that the Whitworth 12-pounder shell would be a more effective shell for field service than the Armstrong shell?—Yes; I think so; but this principle may be applied to the Armstrong shell. The interior of the Armstrong shell may be made precisely the same.

1604. Do you like that form of shell better than the built up shell?—Yes; very much better than having the bursting charge in the centre. If you have the bursting charge in the centre you get a large distribution of bullets or segments, and unless you burst the shell very close to the object, almost the whole of the contents are ineffective—they spread so much.

1605. (*Mr. Pole.*) Cannot the charge be confined to just sufficient to fire off the shell without any considerable lateral distribution?—You cannot hit it off so nearly; you must have an excess of force, otherwise you would have a great many that would not burst. For instance, with this arrangement with the 70-pounder shell only 3 or 4 oz. of powder is used; with the Armstrong shell, 2 lb.

1606. With the Whitworth you have twice the velocity of rotation as with the Armstrong gun, having twice the twist?—There is more rotation certainly.

1607. And more centrifugal tendency?—Yes.

1608. In the Armstrong it is comparatively slight, is it not?—Yes; still I have a great objection to the powder being in the centre. The first improvement which I made in the round shrapnel was separating the powder from the bullets, and placing the bursting charge in the centre. Afterwards I found that the distribution was very much too great, and the destructive effect very trifling, unless the range was known exactly, and the shell burst close to the object. With the present arrangement the powder is so arranged as not to distribute the bullets; but merely to open the shell and relieve the bullets. The great object in a shrapnel shell is to arrange the interior in such a way as to produce as little distribution as possible.

1609. (*Col. Simmons.*) In the experiments which you have carried on with these shells, have they been against large targets which would catch all the particles, so that you might be able to tell the Committee at what distance you could throw all the particles into the head of a column for instance?—No; I have not had sufficient experience to enable me to give an opinion. I made some target experiments some time ago, and with very good results indeed, as far as the penetration and the number of bullets that struck the target were concerned.

1610. (*Col. Ormsby.*) With this form of shell?—Yes; with this form of shell.

1611. (*Col. Simmons.*) Have you had any experiments to show the amount of spread by that system, in comparison with the Armstrong, or any other system?—No; I have never compared it with the Armstrong shell. I have had very little experience with the Armstrong segment shell in firing at targets.

1612. Have you compared the amount of spread of that shell with that of the ordinary shrapnel shell?—I have not made any direct comparison, but from the effect which I have observed on the water and sand, I can see that the spread perpendicularly to the trajectory is comparatively trifling, and that there is very great longitudinal spread, and this is just what is required in a shrapnel.

1613. (*Mr. Pole.*) Is your opinion very decided with regard to the favourable effect of tapering the shot at the back, as to its accuracy?—Yes; I would not believe what Mr. Whitworth said about it until I made the experiment. I could hardly believe that it would make so great a difference in the range.

1614. Is that a new fact, or are there any other experiments, than those which you have mentioned,

on which you base that opinion?—I have always been aware that the form of the hind part of a shot would have some effect upon the range and accuracy, but I was not aware that it would have such a considerable effect as that which I have mentioned.

1615. Are those experiments sufficiently extensive to confirm you in that opinion very strongly?—They confirm what Mr. Whitworth stated to me most positively as the fact, that by this taper form a very great increase in range is obtained. Those experiments, taken in conjunction with what he told me, have satisfied me; the small number of trials I have made would not have been sufficient by themselves.

1616. Have you any remarks to make as to the form of the head of the shot, with reference to accuracy?—No; I have not made any experiments to determine the best form of head.

1617. Do you know anything of the accuracy or want of accuracy of the flat headed shot?—The only experiments which I have seen with flat headed shot, are those which took place at Shoeburyness against the Warrior target, and the projectiles appeared, at the range at which they were fired then, to have been very accurate in their flight. I was rather surprised to find it so.

1618. Then was it your opinion that they were not so accurate?—I did not expect them to be so accurate; but the gun appeared to fire very accurately indeed. With the Enfield rifle bullet the accuracy is destroyed very soon; beyond 300 yards the shooting is very wild.

1619. (*Commander Singer.*) Are you quite satisfied with the accuracy of the Whitworth gun as far as your experiments have gone?—Yes; they appear to be very accurate indeed, and the Armstrong gun also I think is very accurate.

1620. You have had no target practice with the Whitworth gun, have you?—No; not beyond making the experiments with shrapnel shells.

1621. (*Col. Simmons.*) I suppose with field guns, you would consider that either the one or the other have sufficient accuracy for all practical purposes?—Yes; and far beyond all that is necessary in my opinion.

1622. (*Major Young.*) Do you approve of breech-loading for field purposes?—No. I object to breech-loading as it exists at present, either for the field or for any other service.

1623. (*Col. Simmons.*) On what grounds?—I think that the apparatus for securing the breech is exceedingly liable to disarrangement, and that it requires in its management an amount of care and attention far exceeding that which it is reasonable to expect would be bestowed upon it by those who would serve the guns in actual warfare. The small experience which I have had with the Armstrong 12-pounder confirms me in that opinion very strongly indeed. I hardly ever go down to practice but I get into some difficulty with the breech part.

1624. (*Col. Ormsby.*) Are you speaking of the gun which is made with the latest improvements?—Yes; the difficulty which I have got into has been with the screw. In the last experiment which I made in trying time fuses, I found that after about 10 rounds, the breech screw got so stiff that it was with great difficulty it could be worked, and in one case an accident very nearly occurred in this way: the breech piece became very stiff, the man fancied that he had screwed it up securely, and it certainly sounded as if it were screwed up securely, but when we came to look, we found that the breech piece was not even inside the bouche.

1625. What is the cause of that?—It is the escape of gas round the breech piece or vent piece, which gets into the screw and clogs it. This happens even with the 12-pounder.

1626. (*Capt. Preedy.*) Would that be the case with a 70-pounder where they use a cup?—Yes; I have never yet seen an Armstrong gun which did not allow of an escape of gas, and it is much worse with the 40-pounder than it is with the 12-pounder.



1627. Does not using the tin cup do away with the escape?—It does to a certain extent; if the cup fits very accurately then it will to a great extent stop the escape; but great difficulty is often experienced from the fouling of the screw, which prevents the breech piece from being screwed up securely.

1628. (*Mr. Pole.*) Did the man give the usual two blows?—Yes; and it sounded exactly as it does when the breech piece is secure.

1629. (*Col. Simmons.*) Did you remove the breech screw before continuing the firing?—We went on hammering as hard as we could, and we got it up at last, and after that we oiled it, but still it remained stiff. I have been very unfortunate with that gun. Almost every time I practise I get into a difficulty with it.

1630. Do you always go with the same gun?—Yes.

1631. (*Major Young.*) Did you ever try a little water on the thread of the screw?—No; I have never tried water.

1632. (*Col. Ormsby.*) What other difficulties have you got into with that gun, besides the screw going stiffly?—From not being able to get the shot up to its proper place, the cartridge will sometimes project about 3 or 4 inches outside the chamber.

1633. What has prevented its being got to its proper place?—Fouling in the chamber.

1634. Is that after a great many rounds?—No; after a very few rounds, sometimes after the third round.

1635. Do you think that the gun is a particularly bad gun?—When it was first issued to me, I found that there was some little difficulty in getting the shot up, and I sent it to the Gun Factory to get the gun altered. It was found to be incorrect, and was altered to its present shape; it is supposed to be perfectly correct now.

1636. But it still acts badly?—Yes.

1637. (*Col. Simmons.*) Is that gun washed and cleaned carefully after practice, before it comes out for practice a second day?—Yes, always. The last day I fired it there was not the slightest difficulty in getting up the shot, the only difficulty was with the breech screw; the time before that the difficulty was with the shot. It depends upon the weather a great deal.

1638. Did the difficulty with the shot arise from the shot being burred and knocked out of its form, through coming into contact with other shot on the ground?—No, the shot was perfect; we always take new shot direct from the factory.

1639. In what way does the gun clog?—It is from the residue of the powder which forms a hard fouling in the chamber, little hard lumps which prevent the shot from going up.

1640. Is the whole of that residue the residue of powder, or is a portion of lead mixed with it?—It is all from the powder, the lead is in front; the fouling is in the powder chamber, it is purely from the powder.

1641. (*Major Young.*) If you could get a more perfect breech-loader, would you then advocate it for field purposes?—No; under no circumstances would I advocate it for field purposes, if it were the most perfect gun of the sort that ever could be made, because I can see no advantage in breech loading for the field service.

1642. (*Col. Simmons.*) It has been stated that one of the defects of the muzzle-loader is the liability of the shot in passing down the bore to be jammed by extraneous matters, for instance, sand or other substances, which might get in. Do you not think that an objection, which would induce you not to prefer the muzzle-loader to the breech-loader?—It would be a fatal objection if the muzzle-loader were liable to be so clogged as not to enable you to load under all circumstances.

1643. (*Commander Singer.*) Do you think that Mr. Whitworth's gun answers so far?—I should be very sorry to express so strong an opinion as to say that

Mr. Whitworth's is the best gun that can be devised, and ought to be introduced into the service. My experiments have not been sufficiently extensive to test the system thoroughly.

1644. Would it be liable to jam the Whitworth projectile in the question which has just been put to you?—No, if sufficient windage were given to it there would not be that liability, but of course if the windage were not sufficient it would do so.

1645. (*Col. Ormsby.*) Have you fired much with the Whitworth guns?—Not more than 400 rounds.

1646. Did you ever see the shot stick?—Never; I have fired them without sponging, but I have never put any sand in the bore; the gun ought to stand that test.

1647. (*Col. Simmons.*) What cartridges do you use in the practice?—Flannel cartridges, the ordinary cartridges.

1648. (*Major Young.*) Do you not think that there is some danger in a muzzle-loader with such very small windage as Mr. Whitworth's, from the liability of the gun burring the grooves, and so causing the shot to jam or a difficulty in loading?—I do not think that any difficulty of that sort would arise if the material of the barrel was of a suitable character; of course such points can only be determined by experiment.

1649. Would it be an easy thing to get a large supply of shot made so perfectly as always to have the proper amount of windage; would you be able in the laboratory always to supply shot of exactly the same pattern, so that there would be no chance of their being a little wrong?—We work up to an hundredth part of an inch now, and we could do so with the Whitworth, or even to a greater degree of accuracy.

1650. Can you ensure a large supply?—Yes; there would be no difficulty at all about that. There is a certain amount of limit allowed in the manufacture; it would be impossible to make a large number of shot of exactly the same dimensions; there must be a certain limit, but that limit is sufficient to enable us to manufacture very cheaply, without interfering with the efficiency of the projectiles.

1651. (*Col. Simmons.*) What limit do you actually allow in a 12-pounder shot as regards high gauge and low gauge?—

1652. (*Capt. Preedy.*) Do you not consider it necessary to sponge the Whitworth gun after firing?—Yes, certainly, but in order to test the gun I have fired without sponging.

1653. Many hundred rounds?—Not a hundred rounds; but in the experiments at Shornecliffe you may say there was no sponging, for the sponges were so very small that they hardly touched the bore as they went down.

1654. Would it not be a very difficult thing to sponge a rifled gun in firing quickly?—No, I think not, if the sponge were made of the proper material; I think that a bristle sponge would answer much better than the ordinary sponge, and also the sponge should be made to turn round on the staff; there is a great deal of difficulty if it does not do so; but by fixing the sponge part on to a pin it will turn round without difficulty.

1655. (*Col. Ormsby.*) Is there not more liability of part of the cartridge being left behind in the rifled muzzle-loader gun than there is in the old smooth bore?—No; there is, I think, less liability to accident, because the action is more intense in a rifled gun than it is in a smooth bore; in a smooth bore gun the round shot is quicker out of the piece than it is in a rifled gun, and the cartridges will not consequently be so entirely consumed as in the rifled gun. I think there is less liability to accident in the rifled than in the smooth bore, particularly if the vent communication is made near the bottom of the bore.

1656. (*Col. Simmons.*) There would be a more perfect combustion of the powder?—Yes, the heat acts for a longer period.

1657. (*Col. Ormsby.*) Do you think that a gun rifled according to Mr. Whitworth's plan would have

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the same capability of endurance as one of Sir William Armstrong's guns?—I should think so, as far as I can judge; I have never made any experiments with a view to determine the endurance of the gun.

1658. Do you not think that the rapidity of the flight of the projectile would be a greater strain upon the gun and would be likely to wear it out quicker?—It may be more liable to wear the bore, but I think the gun would last an immense number of rounds. The bearing surface in the Whitworth is very large, and from what I have seen with the 12-pounder gun, I am led to believe that there is no fear from undue wear. In that 12-pounder gun, after firing about 200 rounds, the bearing surface was found perfectly smooth, and the part where the windage is just a little rough. In fact the non-bearing surface is worn away more than the bearing surface, from the action of the powder; the action of the powder has been greater than the action of the shot upon it.

1659. (Col. Simmons.) That is a brass gun, is it not?—Yes. The only effect of the wear would be to give it an increased windage.

1660. Not to affect the accuracy of the shot?—Not to any considerable extent; of course it will to a certain extent, but the bearing wears away equally.

1661. (Mr. Pole.) Do you think that all the six sides bear?—Yes; I think so; perhaps not perfectly the same.

1662. Can you depend upon all bearing exactly?—Yes, I think so with that particular form. With the ordinary form there is little use in having more than two bearings. I do not think that you gain much by having even three bearings. I mean with the winged shot.

1663. (Col. Simmons.) When you examined this bore afterwards, did you see any difference in the six bearing surfaces, after firing 10 rounds?—No, none whatever.

1664. Have you made any experiments with the Whitworth gun with regard to initial velocity?—None.

1665. You do not know whether its extreme rapidity of twist produces much effect upon its initial velocity, either diminishing it or otherwise?—No, only from what I have heard; the Ordnance Select Committee made a number of experiments on initial velocity.

1666. (Col. Ormsby.) Is the cost of the Whitworth projectile relatively greater or less than that of the Armstrong projectile?—If you have the same iron as is used in the Armstrong, the cost is less; if you take advantage of a heavy material in the Whitworth, the cost, perhaps, would be greater.

1667. Do you know the gun that Mr. Whitworth proposes, made of homogeneous metal?—No; I know nothing at all about that gun. As to the common shell, I calculate the cost, taking the 40-pounder as the average size, and so far as I am able to judge at present, (I have not had very much experience of the manufacture of the Whitworth, but still I can form a pretty correct judgment from the experiments that I have made,) I estimate the Whitworth 40-pounder common shell at about 3s. 4d., the solid shot about 2s. 2d., and the Armstrong 5s. 3d. the common shell, and the 40-pounder shot 3s. 8d. The difference is principally due to the lead coating, and the additional work after turning the iron.

1668. (Col. Simmons.) Are those contract prices, or prices derived from your factory at Woolwich?—Those are our own prices, not contract prices.

1669. Including the material and the workmanship?—Yes, and everything else, all the contingent expenses; it is a fair comparison between the two; we put 50 per cent. upon the wages for contingent charges in making an estimate.

1670. (Col. Taylor.) You do not calculate your charges exactly upon the same scale as a manufacturer would?—No; we do not charge profit.

1671. (Mr. Pole.) Is the hexagon form at all disadvantageous as regards the contents of the shells?—No.

1672. Is there not a loss at the angles, so that you cannot get so much destructive material into it as into the cylindrical shaped shell?—Mr. Whitworth makes the common shell longer in order to contain the proper quantity of powder, and he finds that he is able to increase the length sufficiently to contain the proper charge without interfering with the accuracy or the range.

1673. (Col. Simmons.) Have you the machinery fitted for planing those shells at your factory?—We have only a makeshift arrangement, not the proper arrangement.

1674. Mr. Whitworth states that he planed those shells for 3d. a dozen; that is a very material item, is it not, in the cost of the shell?—Yes; that would be only the actual piece work price of the man who is planing the shells, and perhaps this man would have half a dozen machines to superintend; I assume in my calculation that the proper machinery is used.

1675. (Mr. Pole.) Do you allow for the cost of machinery, and the interest of capital and repairs?—Yes; we should not require so much machinery for the manufacture of the Whitworth as for the manufacture of the Armstrong projectiles.

1676. Do you turn the lead?—Yes; we cannot obtain sufficient accuracy without turning it; we find it is cheaper to turn the lead than not to turn it.

1677. Do they not supply from Elswick shells sent directly from the mould, with the exception of a little groove, which is turned round the ends?—I do not know, but we should not be satisfied with the accuracy obtained by that arrangement; we are very particular, not only about the accuracy of the exterior, but to have the fuse hole exactly in the centre, and perfectly true. All the shells which were attached by means of tin and with grooves, have become unserviceable, and there are somewhere about 100,000 in the Arsenal now, which we have to re-lead; I am engaged upon that service now, and I find that the fuse hole is very much out indeed, which is the great difficulty that we have to contend with in re-leading them.

1678. Is not that determined by turning the shell before the lead is put on?—No; if you merely leave the lead as it comes out of the mould, you cannot be sure that the fuse hole will be in the centre; we turn to a single centre, which is continued throughout the whole of the processes: we commence with a centre, and we go on from one machine to another, using the same centre, the shell always centring itself up to the same point; if the lead is not turned it will be thicker on one side than on the other.

1679. (Col. Ormsby.) All the ammunition goes through your hands, does it not?—No; I have nothing to do with the shells and fuses supplied by the Elswick Ordnance Company.

1680. Is it served out direct?—It is inspected by the Inspector of Artillery, and then served out. We have sometimes to alter shells for experimental purposes, and now we are re-leading the whole of the shells which have become unserviceable from the loosening of the lead coating.

1681. (Mr. Pole.) Was that mode which you have found defective an experimental mode of attaching the lead?—No; it was a mode introduced into the service, and all the shells made at Elswick, up to within a year ago, have been made in that way.

1682. Was that before the under-cutting, and before the zinc process was adopted?—Yes; the under-cutting system was adopted for Elswick, and the zincing was adopted for my department. I proposed zincing for all natures of shells, as I felt perfectly satisfied that the other method would prove a failure; and it has proved a failure.

1683. (Col. Simmons.) How long has that zincing process been introduced?—It was introduced about two years ago.

1684. Have you observed the same defects in the shells that are zinced, as those that you have described, with regard to the tin ones?—No; there is no loosen-



ing at all. I should be very sorry to express a strong opinion that even the zincing will stand all climates.

1685. Was that loosening produced by chemical action between the metals, or how was it caused?—I expect it was from corrosion principally. In the zincing process the two metals are joined; it is one mass; there is a complete adhesion, and there are no grooves in the shell at all.

1686. Was not the tin process much simpler?—No, it did not answer.

1687. Was the tin put on in the same way as the zinc?—Exactly the same. When I first commenced manufacturing, I started with the tin process, the same as at Elswick; and I discovered that there was no adhesion whatever between the lead and iron. After it was coated, if you cut the lead down to the iron of the shot, the lead would peel off without difficulty; I then recommended the zincing process, a system which had been carried out by Mr. Bashley Britten, and which has answered perfectly well up to the present time.

1688. (*Major Young.*) Do you conceive that it is desirable to give as great a twist as Mr. Whitworth adopts in his system; is it not likely to give an extra strain to the gun?—Yes; I think it gives a slightly increased strain to the gun, but I do not think the increased strain due to the greater spirality matters much with a strong material. It would be very objectionable with cast-iron; but with wrought-iron, or steel, or brass, there is nothing to fear from the strain.

1689. (*Col. Simmons.*) Does that rapidity of twist increase the penetration of the shot?—I do not think so; a rapid twist is necessary with Mr. Whitworth's system, because he makes the shot so long that they would turn over in flight unless the rotation was rapid.

1690. Mr. Whitworth stated the other day that he considered that the rapidity of the twist increased the penetration; that the motion had to be annihilated on coming in contact with any object, and that that would tend to increase the effect of the shot; do you agree with that view?—I do not see how it can do that. It might give a slightly increased push to the projectile as it passes through the target.

1691. (*Major Young.*) He also said that one of the advantages of this great twist was to enable him to use different lengths of projectile for special purposes, and to fire with small charges. Do you consider it applicable to the service to use those different lengths of projectile with the same gun?—Upon that question the experiments that I have seen have hardly enabled me to form an opinion. I do not see why shot of different lengths should not be fired from the same gun if you have sufficient twist to give steadiness to the long shot. Mr. Whitworth has made some experiments with different lengths of shot, and they seem to have been successful.

1692. (*Col. Taylor.*) Mr. Whitworth was saying the other day, when he was asked with respect to his ammunition, that he had no ammunition in a finished state to bring before the Committee at all. Have you a common shell and a shrapnel shell in a state ready to bring forward for an experimental trial?—The experiments that I have carried on are not sufficient to enable me to say that that particular shell is perfect. A certain number of preliminary experiments will be required before I can produce a perfect shrapnel shell, either for the 12-pounder or the 70-pounder.

1693. What is your own opinion with respect to the very great elongation of a projectile to serve as a common shell; do you consider that that is likely to affect its efficiency as a common shell, either advantageously or otherwise?—No. I do not think that it will do so.

1694. Have you ever seen a shell burst in one of Mr. Whitworth's guns, from a defective fuse?—I have had some shrapnel and three common shells burst in the gun in the first experiments made with those shells.

1695. That has happened?—Yes.

1696. Have you found that to do any injury to the bore of the gun, so as to interfere with the loading?—Not the least in the world; but the bursting charge was very small. A common shell might injure the bore if the bursting charge were large; that is a matter for experiment.

1697. Do you think that the bursting of an ordinary shell with a bursting charge, say of 1lb., such as that of a 20lb. shell, would interfere with the surface of the bore, so as to prevent your getting a hexagonal shot home?—With the present windage very probably it might, but it would have to be tried. I cannot give any decided opinion about it.

1698. (*Col. Simmons.*) That would also depend upon the material of which the bore is composed?—Yes, to a great extent.

1699. (*Col. Taylor.*) You consider that the shells are in comparatively an experimental state as yet?—They are very nearly complete.

1700. How do you account for the ignition of the fuse in the shrapnels that were fired the other day at Shoeburyness, a considerable time before the bullets were projected from them, and before the contents of the shell were discharged, which happened in a great number of cases?—I have never seen anything of the sort.

1701. It was observed that at about one-fourth of the whole ranged from the target the fuse apparently fired, and the shot did not escape till afterwards?—I think the observer must have been mistaken; never having seen any of those shells fired before, they are very likely to have been mistaken. The quantity of bursting powder that is used is very small; from about 6 drachms to 8 drachms. The effect of those that we fired the other day at Shorncliffe was seen very well indeed upon the water, and nothing of the sort happened.

1702. What would be the number of bullets in a 12-pounder?—40 bullets, and about 10 segments. I could not get any bullets to the small part of the shell, so segments were substituted.

1703. (*Col. Ormsby.*) You would prefer those shells, with your Boxer's fuses, to the Armstrong's with the time and concussion fuses?—I prefer this arrangement of shell; in fact, I adopted this arrangement, thinking it preferable to the arrangement which had been followed by Sir William Armstrong.

1704. And the fuses likewise?—Yes; but there is no reason why the ordinary wood fuse should not be used with the Armstrong shell, if a certain addition is made to it, to ignite the composition. I am now carrying out experiments with the object of igniting the fuse by a detonating arrangement. There is no windage in the Armstrong gun, and therefore you are obliged to have a detonator to ignite the composition, in the same way as is done with the present pattern fuse.

1705. (*Col. Simmons.*) What is your objection to the concussion fuse and the time fuse, as adapted now to the Armstrong shell?—I do not think that the concussion fuse is of so much use. I think it is a wrong principle to burst a shrapnel shell upon the ground, considering the ground that you are likely to be firing over under ordinary circumstances. On hard level ground it does not matter very much; but I think that, on ordinary ground, you will find that a very large proportion of the contents of the shell would not rise, and the velocity also of the contents would be diminished considerably. In the time fuse, I think the arrangements are of too complicated a character, and are not likely to be properly regulated in the field, I consider the system a defective one. I very much prefer the simple plan of boring a little hole in the fuse to turning a cap round and screwing it up, particularly when a defect in the screwing up causes the shell to burst in the gun, which is a most serious defect, and sufficient to condemn any system; but there is no reason why the ordinary wood fuse, or any other fuse, may not be adopted by Sir William Armstrong as well as by Mr. Whitworth, the only difference between the two systems is that the addi-

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tion of a small detonating arrangement to ignite the fuse is required with the Armstrong shell.

1706. (*Col. Simmons.*) Is the chance of a man's being neglectful in arranging the time fuse for an Armstrong shell such as would prevent your firing, or make you uneasy if you had to fire a shell over the heads of your own men?—I feel perfectly satisfied that the fuse never could answer in the field.

1707. You would not use it to fire over your own men's heads?—No; I consider it unsafe, if the men do not adjust it properly; that is to say, when you unscrew the cup you must screw it up again; and if you do not, the shell goes to a certainty. It is an exceedingly pretty fuse, and answers very well for ordinary practice; but I do not think that it would be properly regulated by the men in actual service.

1708. (*Col. Taylor.*) Would you fire a common service fuse over troops, and in front of them?—Yes; certainly.

1709. At what distance?—That all depends upon the length of the fuse.

1710. You would not require a very long range to fire. If you were firing, we will say, at 500 or 600 yards with a shrapnel, would you object to fire over the troops with the common service fuse?—Not the least. There is one very great objection to the Armstrong fuse at present in a service, and that is the india-rubber disk which is applied to it; but experiments are now being made with a view to substituting some other material.

1711. (*Major Young.*) Have they not substituted leather for india-rubber?—It is not substituted yet, the experiments are not yet finished; they are trying leather and cork, and cloth.

1712. Do you conceive that the difficulties which were experienced with the former time fuses will be got over by the new pattern ones, that is to say, all the difficulties of keeping?—Certainly not, if the india-rubber washer is retained.

1713. Why is that?—The india-rubber is the principal cause of the defect. It sticks to the paper, and prevents the proper action of the moveable disk. I have very great doubts about the keeping of the present pattern time fuse, independently of the india-rubber.

1714. Do you think that those tube communications are likely to remain in their present normal condition?—No; certainly not. We find where gunpowder is in contact with metal, that there is a great deterioration both of the metal and of the gunpowder. The old naval fuse was altered for that reason. I applied a paper lining to it, because we found that the composition of the fuse became so much deteriorated, that it burnt very irregularly.

1715. (*Col. Simmons.*) Was that from dampness getting into it, do you suppose?—No.

1716. Those of the late pattern are hermetically sealed, are they not?—Yes. But the dampness may be inside the fuse before it is sealed; and if the very greatest precautions are not taken in drying all the parts before they are put together, the damp in the interior would destroy the composition very soon.

1717. (*Col. Taylor.*) Do you think that the elements of deterioration are in the fuse, independently of the admission of air altogether, and supposing you could close the fuse quite hermetically, do you think that there would still be a liability to injury?—Yes; although not so much, probably; of course the action would not be so rapid as when exposed to the atmosphere.

1718. (*Major Young.*) Do you suppose it is the saltpetre that is in the composition that attacks the metal, or is injured by the metal?—Yes, and the sulphur.

1719. (*Mr. Pole.*) Is not each piece of brass lacquered before it is put in?—Yes; but still notwithstanding that the action goes on. It preserves the metal to a certain extent, but not sufficiently. We find even when lacquered that deterioration takes place; and it is a very small quantity of gunpowder that is used in the Armstrong fuse; it is only one-

tenth of an inch deep. There is a very large portion of the surface of the metal in the ring exposed.

1720. (*Col. Simmons.*) Have any of those fuses that have been returned to you been in hot climates, and has the heat affected them much?—The whole of the time and concussion fuses in store have been lately condemned.

1721. How long had these fuses been adopted before you found out that they were liable to this deterioration?—I had nothing to do with the construction; we have made very few indeed.

1722. If there has been no experience with the present fuse, it may be liable to similar defects, may it not?—Yes; we have had no experience of it as yet.

1723. (*Col. Ormsby.*) Are any of the present fuses issued to the service?—No; there are none of the new pattern time fuses and concussion fuses ready for issue. We are making some 50,000 of the new fuses, but we have not issued any yet. Elswick, I think, has delivered a great many, but we are waiting for some alteration. I think the india-rubber is being tried.

1724. (*Major Young.*) You made a number of experiments with the pillar fuse, did you not?—Yes.

1725. Do you consider it a good fuse for the purpose for which it is intended, that is to say, that it should not be too sensitive, and that it may be used on board ship?—It seems to answer the purpose very well; but I do not like the fuse; it is too delicate, in fact, and it is liable to accidents. I find that if the pillar fuse projects beyond the shell about one-tenth or two-tenths of an inch, and you drop it from a height, the shell will explode, and I do not think the height need be very great to cause it to go off. All this delicacy is not in the slightest degree necessary; you may make the fuse to answer all purposes without all this delicacy.

1726. (*Major Young.*) In fact, you think the fuse may be made without the complication of the pillar at all?—Yes.

1727. One of the advantages of the pillar fuse is, that provided the shell strikes en ricochet, then, by the arrangement of the pillar, the composition being on the side of the pillar as well as on the end, it will act as well as if it struck on the point; could you have a simple fuse which would be easy to make, and which would fulfil these conditions?—I do not think that condition is of any importance, because when a shell once touches the ground, it is all up with it; there is no chance of its reaching the object you are firing at.

1728. But in the case of the navy, would it not be an advantage?—If it strikes the water within 20 yards of a ship it will go right over the ship. I do not think it is necessary to provide for the shell bursting after ricochet. If it does strike it will act as a shot, supposing the fuse does not explode. There is no more difficulty in making a good percussion fuse for the Armstrong shell than there is for the Whitworth shell.

1729. Do you know whether there have been any experiments made with respect to the keeping of the detonating composition in hot climates; do you know whether the composition itself deteriorates by keeping?—The only experience we have had has been with the Moorsom fuses, and we do not find that the composition in them deteriorates at all. We always, as a rule, reprime them when they come from abroad; still, the composition is generally found to be in a very good state.

1730. (*Chairman.*) I think I understood you to say that you have no record of the experiments that you have tried with the Whitworth guns?—No; everything is recorded, but the experiments I have referred to were made with the view of determining the best arrangements for the shells, and I do not think they would be any use to the Committee. I have not made a sufficient number of experiments to enable me to guarantee the action of the shell. I should require a few preliminary trials, probably not many; I think I could very soon settle the matter.



1731. (*Col. Taylor.*) Could you give the Committee an idea how soon you would be able to get ready say 50 rounds of that shell to try with the fuse which you would propose for the service; I say you propose, because I take it for granted, from what Mr. Whitworth said, that he does not intend to bring forward any fuse?—You would use the ordinary wood fuse of the service. I think I could answer for having shells prepared as quickly as the gun is prepared, if I have authority at once to carry out the necessary trials. I could make the preliminary trials with the 70-pounder which is at Shoeburyness.

1732. (*Major Young.*) Have you a common shell for the 12-pounder Whitworth?—A 12-pounder common shell would be of little use, it would hold so small a charge of powder; I would use the shrapnel as a shot, shell, or case shot. I would use it as case by bursting it just outside the muzzle. It would not be safe to fire the ordinary case out of the Whitworth gun.

1733. (*Col. Ormsby.*) Is the shell lying before you the same shell that you had at Shorncliffe?—Yes, only it is strengthened in the rear. At Shorncliffe five of them broke, and that was the reason why I was anxious to get a parallel base; the bearing comes so far in front that there is a very great leverage tending to break the rear part; now I have increased the strength of the shell, and brought the chamber further forward.

1734. (*Col. Taylor.*) Do you fill in the space between the bullets as you would in the ordinary diaphragm shell?—Yes, with rosin.

1735. (*Major Young.*) Do you conceive that for the penetration of iron plates, it is an advantage to have the different shot flat-headed?—They answer under certain conditions. I believe the penetration with the flat-head is greater than it is with the round when the target is much inclined; but in the case of the vertical target, I do not suppose there would be very much advantage one way or the other.

The witness withdrew.

Adjourned to Thursday next at 11 o'clock.

Thursday, 29th January 1863.

PRESENT :

MAJOR-GENERAL RUMLEY, Inspector-General of Infantry.  
COLONEL ORMSBY, R.A.  
COLONEL TAYLOR, R.A., Commandant School of Gunnery.  
CAPTAIN PREEDY, C.B., R.N.

COLONEL SIMMONS, C.B., R.E.  
COMMANDER SINGER, R.N.  
MAJOR YOUNG, R.A., Director of Artillery Studies.  
WILLIAM POLE, Esq., F.R.S.

CAPTAIN DYER, R.A., Assistant Inspector of Artillery, Secretary.

MAJOR-GENERAL RANDAL RUMLEY IN THE CHAIR.

Captain HENRY WILLIAM GORDON, C.B., examined.

1744. (*Chairman.*) What position do you hold?—That of Principal Superintendent of Stores.

1745. Do all the guns that are issued to the service pass through your hands?—All.

1746. And any that are damaged during the time they are in service, do they return to your hands?—They would come back to me.

1747. Have you any return of the number of Armstrong guns that have been returned on account of failure?—I could supply such a return.

1748. Could you furnish the Committee with a return of the number and natures of the different guns issued, the number of rounds fired, and present condition of the guns; the number of guns returned for defects, the date of manufacture, the nature of the defect, and the cost of repairs?—I will get that return prepared.

1749. Could you also give a statement of the expense of sending them for repair?—I could not include the expense, as they are always conveyed in

1736. (*Col. Taylor.*) You mentioned that you have an idea of turning the head of the sponge, do you not think you diminish the cleansing effect of the sponge by that arrangement, and that you would have less of the action of the sponge than if you pulled it out by force, always, of course, supposing that it will turn in the man's hand?—You would have as much cleansing action as you have in the smooth bore at present.

1737. (*Mr. Pole.*) Have you seen much practice with the shunt muzzle loading gun?—No; I have not seen it fired. I saw a little practice with a cast-iron shunt gun at the competitive trials, but those are the only trials I have seen with the shunt gun.

1738. (*Col. Simmons.*) You place some lacquer on the lead covered shot to preserve it, do you not?—No, we put the black paint over the joining to the two metals, the same paint as is used for the head and rear of the shot.

1739. Does it require constant renewal?—I do not think it will with the zinc process. I think the zinc process will prevent the separation of the two metals, and I do not see any reason at present to doubt the efficiency of that arrangement.

1740. (*Col. Ormsby.*) You stated that there were a great number of shot at Woolwich which required re-leading now, is that a great expense?—It is a considerable expense, but it is less expense to re-lead than to break them up. It will cost about 10*l.* a hundred, or something of that sort; the same lead coating can be used over again.

1741. Have the shot become unserviceable from lying in the store?—Yes.

1742. Do you think that that is likely to occur with shot made by this new process?—I do not think so.

1743. (*Chairman.*) Are there any other facts which you would wish to state for the information of the Committee?—No; I have nothing further to state.

*Lieut.-Col.  
E. M. Boxer,  
R.A.*

26 Jan. 1863.

*Captain H. W.  
Gordon, C.B.*

29 Jan. 1863.

*Captain H. W. Gordon, C.B.* repair are merely those that cannot be repaired at the station, are they not?—Just so.

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1752. All minor repairs are performed at the stations?—All minor repairs would be performed at the stations; I have not heard of any being required.

1753. (*Chairman.*) Are all the guns that are experimented with returned in like manner?—Yes, all.

1754. Of course they are never experimented with until they have been proved, are they?—Some experimental guns have been experimented with without proper proof, but they would never be service guns unless they had been proved.

1755. (*Col. Simmons.*) You issue all tools from your department, do you not, that are necessary for the small repair of those guns at the stations?—The tools are now in course of issue, but there is one set which is connected with the smiths' tools, which would be supplied from the Tower, some of the portions being made at the gun factory.

1756. Special sets of tools for the repair of Armstrong guns, such as for the repair of the bouching, you would supply?—All the facing tools would be issued with the guns.

1757. They are very complicated tools, are they not?—Extremely complicated, from the number of changes in the patterns; they are different for every description of gun.

1758. That tends very much, does it not, to complicate the use of breech-loading guns as compared with muzzle-loading guns?—It tends to complicate the drawing up of the details, and it is almost impossible to keep pace with the changes in the pattern. I do not know whether that would be effected more by the breech-loading than the muzzle-loading.

1759. In the old muzzle-loading smooth bore gun you have no implements at all to issue, have you?—Only the implements for re-venting them, which are very expensive.

1760. (*Chairman.*) Of course, those returns which you are about to furnish, would include all rifled guns, whether Whitworth's or Armstrong's?—All the Whitworths have been experimental guns. They have been confined to a few only, one of which, an 80-pounder breech-loading gun, became unserviceable.

1761. (*Col. Simmons.*) Have you had any wedge guns upon your books?—There have been some issued to the Select Committee, and they are going now for experiment to Portsmouth, Devonport, Sheerness, and Dover.

1762. Have you had any of those come back to you as damaged?—They have been only used by the Select Committee, but they have required re-arrangement as to various matters after they have come back.

1763. (*Major Young.*) Have any of those guns been passed into the service?—There have been a few, but there are a hundred in course of construction at Elswick, 70-pounder side-loading guns; and there are 12 40-pounders, and eight 110-pounders in course of manufacture in the gun factories.

1764. (*Col. Simmons.*) Are there to be extra wedge pieces issued with those guns?—They certainly will require them, and facing implements as well.

1765. Has the proportion been fixed by regulation?—The proportion would be similar to the proportion laid down for vent pieces. The Navy are not contented without four vent pieces for every gun. And the same proportion of stoppers and wedges ought to be supplied.

1766. The entire sliding apparatus, in fact?—Yes.

1767. Those are very heavy and bulky for the large guns, are they not?—For the 110-pounder I have no doubt they would be very large, but there has not been one made yet; for the 70-pounder they are not very large.

1768. Do you know why it is anticipated that those spare slides will be required?—For the same reason as applies to the vent pieces. The necessity

to supply spare vent pieces would involve the necessity to supply other spare articles.

1769. (*Major Young.*) Have you found any of those wedges get out of order in store by cleaning and looking after the gun?—No; but there have been none in store except a few for experiment.

1770. (*Commander Singer.*) In fact, the wedge system must be looked upon as entirely experimental as yet, must it not?—Entirely as experimental.

1771. (*Capt. Preedy.*) Has any gun on the side-loading principle been returned as unserviceable?—Not as unserviceable, but repairable after proof.

1772. Do you know what part gave way?—Various parts of the side arrangements gave way. There have been only three 70-pounders made, and two 40-pounders; of these, one of the 70-pounders and one of the 40-pounders had to be repaired after proof.

1773. (*Col. Simmons.*) Could you furnish a sufficient return similar to that for guns as regards vent pieces; could you give the Committee a statement of the number of vent pieces which have been returned as damaged?—The return would be general. It would not be in consequence of the vent pieces breaking, but in consequence of the introduction of iron in place of steel.

1774. Could you distinguish those which have been returned from having been injured?—A return could be given of the vent pieces which have come back damaged; but the whole of the vent pieces have been exchanged recently.

1775. (*Major Young.*) Are you acquainted with the manner of proving vent pieces?—Yes. So far that the vent pieces require the same proof as the gun; but the Inspector of Artillery will be better able to reply to that question.

1776. Is that an expensive business?—It is; a large number of guns have been destroyed by proving the vent pieces, which is occasioned by there being so many spare pieces in excess of the guns proved; therefore guns have to be put specially on one side for proving vent pieces.

1777. Are those guns, generally speaking, serviceable guns?—They have been serviceable guns. A special 110-pounder gun is in course of construction for the proof, so as to avoid taking service guns for it.

1778. Is a large charge of powder usually employed?—Yes, the full proof charge.

1779. And this very soon damages an ordinary gun?—The guns go at different stages.

1780. But much sooner than in ordinary practice, I presume?—Some guns have gone up to an enormous number of proof charges; but that would appear in the return; the Inspector of Artillery will put down the number of rounds fired.

1781. (*Chairman.*) With whom does it rest to declare projectiles unserviceable?—As far as the Elswick manufacture is concerned, the Inspector of Artillery, and as far as the Laboratory manufacture, the Laboratory; but none of the Laboratory projectiles have been found unserviceable.

1782. (*Col. Simmons.*) With regard to those shells which have been rendered unserviceable by reason of the tin process, are they in such a state that they could not be re-issued?—That is the case.

1783. Practically they are unserviceable, though they may be modified and changed to make them serviceable?—Yes; and they are to be withdrawn from all the field batteries for that purpose.

1784. How long was it after the tin process was adopted before you discovered that it would not last?—The order came out in February 1861 that all shells were to have their lead fixed by means of under-cutting; but the tin process went on for a considerable time afterwards, and as far as Elswick was concerned, they continued to deliver shells with the lead fixed by means of tin only. The zinc process was introduced in the Laboratory shells before it was extended to Elswick.

1785. How long was it after the adoption of the



tin process before it was discovered that those shells were likely to become unserviceable?—From the commencement of the introduction of the Armstrong gun, which was at the commencement of the last China war, when two batteries went to China; viz., from December 1859 up to February 1861; a little more than one year.

1786. Have you had any experience of the process last introduced?—No, we have not; but we have had no complaints.

1787. For what length of time have they been issued?—Since about September 1861.

1788. Had you no complaints during the first year of the tin process being used?—Complaints were received from China of the lead stripping off the shells in firing.

1789. Was that attributed to a defect in the tin process?—I do not know. It caused a reconsideration of the question as to how they should be coated; but it now rests between the Select Committee and the Inspector of Artillery whether, if the lead is loose upon the shells, it matters at all. Fifty are to be sent down to Shoeburyness for trial.

1790. (*Commander Singer.*) Is the zinc process in use both at Elswick and at the gun factory?—The Elswick company have just begun; but in the Laboratory it has been in use from the first except with the 20, 12, 9, and 6-pounder segment shells, which were always to be under-cut, but now they are to have their lead attached with zinc.

1791. (*Col. Taylor.*) Do you conceive that any data which could be laid before the Committee, based upon practice carried on with our present shells, would be regarded as a criterion of the efficiency of zinc?—I certainly do not; but it is extraordinary how few complaints have been received.

1792. (*Col. Simmons.*) Is there a very large number of those shells prepared by the tin process now out with the artillery?—An immense number, all over the world, both on land and at sea.

1793. Are they all ordered now to be sent in to Woolwich to be exchanged?—No; only from the field artillery.

1794. Could you furnish the Committee with a complete list of the extra tools and stores which are issued with the Armstrong breech-loading guns?—Yes, certainly; but it would be difficult to define; it would have to be stated whether this gun was for land or for sea, for boats, for the armament of ships, for field, or for garrison artillery.

1795. Would you take one gun for each purpose, and state what you issue for that gun, that is to say, the entire equipment of one gun issued, say, for the armament of a ship; the stores required for the repairs of the gun and for exchanges within the gun; and also the same with regard to one gun for boat service, one gun for field artillery, and one gun for garrison artillery?—I will.

1796. Do you issue spare bouch rings?—Yes.

1797. The bouch ring of the 110-pounder is different from that of the other guns, is it not?—The 110-pounder is bushed in two different ways; first it is bushed with a thick iron ring, and when that has become damaged a thin iron ring is screwed over it; but the guns in the course of manufacture, now, will only have the thin ring, and therefore it is difficult to supply foreign stations. A demand came from the Cape the other day for the two ships, the "Narcissus" and the "Orestes," to supply spare bush rings, and as they had not sent the register number of their guns it was impossible to know whether they wanted thick or thin rings.

1798. Have those guns now being used the old thick bouch rings?—The guns that are now being supplied, if they have been bushed before, have the thin ring screwed over the thick one; but all guns newly manufactured are to have the thin ring only. In rebushing the thick ring is reduced, and the other ring is screwed on to the top of it.

1799. Is there a difficulty in rebouching those that have the thick ring?—Artificers are being sent to

every station to cut down the thick bush and screw in the thin one above it, which is a most delicate operation, since if the ring gets damaged the gun must be brought to Woolwich.

1800. The ring which remains in is extremely thin, is it not?—Extremely thin.

1801. (*Major Young.*) Does the thin ring ever become enlarged by firing?—I do not know.

1802. (*Col. Simmons.*) With regard to those which have been rebouchd with the thin ring, has the bouching of them given way?—We have not had any experience of them yet, but guns which have been sent to Shoeburyness have come back, but I do not know whether it was from that cause or not.

1803. Do you know why the thick ring was abandoned in the bouching of the 110-pounder?—At first the gun had no bush; then a copper one was issued; then the copper one was replaced by an iron one of the same size; and then that iron one has been rebushed with a thin bush, and the new guns will be thin bouchd only; but the reason for those changes I could not give you.

1804. Would not it be possible to rebouch a gun with the thick ring again?—I cannot tell you that, it is a question which is entirely entertained by the Select Committee.

1805. (*Chairman.*) Have you been unable to comply with the demands of the ships "Narcissus" and "Orestes" in consequence of not knowing the numbers of their guns?—I keep a record, and if the ships have not changed their guns I know what guns I gave the "Narcissus" when she was fitted out, and I also know what guns the "Orestes" had; but if I had not had that information, or if they have changed their guns since, I could not comply with the demand. When ships practising abroad report defects in their guns, unless they state particularly the description of the vent piece, whether it is a new gun or an old one, or the number of it, one cannot form any opinion as to the cause of the damage.

1806. Would the number of the gun suffice?—It would be quite sufficient for the gun, but it would not be sufficient for the vent pieces.

1807. (*Col. Simmons.*) This must complicate your stores immensely, must it not?—Yes, extremely so.

1808. (*Chairman.*) In the case of a simple article, how do you know what is meant when they talk about a new or an old gun?—They must give the marks that are on the vent piece, and they must also state whether it is marked iron or steel; if they give those particulars, there could be no difficulty in arriving at a conclusion.

1809. (*Col. Simmons.*) In case of operations on a large scale, a war for instance, it must be exceedingly difficult for you to maintain the guns in all the foreign stations, and to supply them with all those necessary articles, must it not?—I do not believe that, in the present state of things, it would be possible to do so, the changes are so frequent.

1810. (*Col. Taylor.*) Do you not conceive that when a decided alteration is made and recognized as an improvement, it would be the best economy to withdraw at once all of the obsolete pattern; do you consider that that would be advisable or not?—I would certainly do so with ammunition, but in such matters as the sights of guns I think they might remain. The change of pattern is so great in the iron bursters of shells and the concussion fuses which are used with them, that it would be extremely inconvenient to have, in the same battery or on board the same ship, two descriptions of bursters and two descriptions of the same fuse, because you would not know what you had inside the shell.

1811. Is that liable to occur in service?—It would occur, but the whole of the time and concussion fuses are to be returned to be broken up, and the whole of the iron bursters at present in the service for the 25-pounder will be converted into bursters for the 12-pounder, and those for the 12-pounder will be converted into the 9-pounder, and the segment shell will be withdrawn in consequence of complaints made

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the other day. In fact, in consequence of the complaints which have been made, the improvement is very great. For instance, the old fuses were obliged to be packed in waterproof bags, and in tin canisters, whereas the present new concussion fuses require no packing at all; they can go loose, and are ready to be taken out and used at any moment.

1812. (*Col. Ormsby.*) Are you aware of any of the fuses exploding while they have been in course of removal?—I am aware of a case in which a pillar fuse of Laboratory manufacture exploded while in course of removal from the Laboratory to one of my store houses, but it fortunately was in a box.

1813. Did it fall down?—The box merely touched the bottom of the cart as it was being removed from it.

1814. (*Chairman.*) Was it one of the newest pattern?—It was one of the first made in the Laboratory of the present pattern.

1815. (*Col. Simmons.*) Was it fixed in a shell at the time?—No, I am happy to say it was not. Fortunately not one of them had been issued; there had been 15,000 made.

1816. (*Capt. Preedy.*) Were those fuses for sea service or land service?—For both. We were, at the time, travelling a limber over Shooter's Hill Road, packed with the fuses in the fuse holes, and the cart-ridges in the limber boxes for experiment, to see how they would travel. We were going to issue the fuses in the fuse holes, but this stopped it.

1817. Are the pillar fuses now issued for land service?—Yes.

1818. (*Col. Ormsby.*) Did that limber which you have spoken of travel far?—It went 100 miles.

1819. Do you travel many limbers about?—It was the habit, but it is not now. The 40-pounder travelled well, but some of the field battery shells have come in from the horse artillery with their bases enlarged; you could not put them into the breech-screw.

1820. Was it the last pattern shell?—No, none of the last pattern shell have been issued.

1821. Do you think it is the fault of the construction of the limber box?—Perhaps so to some extent. If the base of the shell rested upon something fitted to the bottom of the limber box to keep the lead off, it would not be driven out, but the lead being soft and projecting below the iron, of course the continual hammering would make it spread out.

1822. Do you know of any ammunition coming into your department unserviceable from drill, or of guns travelling, and will you state what it was?—When the horse artillery changed their 12-pounder guns to 9-pounders, they gave in their ammunition,

and out of 1,486 shells given in by two batteries, 394 were unserviceable.

1823. (*Chairman.*) From what cause were they unserviceable?—Some in consequence of their having their bases enlarged; but as to the others, the Inspector of Artillery did not favour me with the reason of their becoming so. There were other reasons, which I am not acquainted with, but I know that he condemned them.

1824. (*Commander Singer.*) Have you had any 110-pounder shells returned as unserviceable from the same cause, namely, the enlargement of the base?—No; there have been no shells returned, except a quantity of gun factory 110 pounder common shells, which were returned from Shoeburyness about four months ago.

1825. (*Colonel Simmons.*) With reference to that fuse which you spoke of as having exploded in your store, when was it made?—About a year ago.

1826. Was it of the last pattern?—Yes, except that the composition has been changed; it is to be Moorsoom composition instead of the composition which was used before, as being less sensitive.

1827. In all the fuses that are now made, that composition is no longer used?—No. With regard to the composition of the fuse which exploded, the Superintendent of the Laboratory would no doubt explain the cause; at any rate, all the fuses of that description, that were made, were withdrawn and broken up.

1828. (*Captain Preedy.*) Were any of that description of fuses issued to the ships abroad?—No; not one of that description was ever issued; it was found out in time. You cannot examine these fuses, they are hermetically sealed when they come from Elswick, and they may leave out anything; you have no means of examination.

1829. (*Col. Simmons.*) In the fuses of the last pattern which have been abandoned, the india-rubber ring was subject to decay, was it not?—It was from various causes. The present new pattern has the india-rubber ring, but it will be superseded by either leather, cork, or cloth, but it is not settled yet; it is still in abeyance, it is in course of consideration before the Select Committee.

1830. (*Chairman.*) Have you ever known any accident from the ordinary fuse of the service exploding?—The wooden fuse could not possibly be ignited except by putting fire to it; but the three Armstrong fuses, the time, the concussion, and the percussion fuses, are all percussion fuses, and of course require the greatest care to guard against the chance of anything being omitted in the manufacture.

The witness withdrew.

Captain Sir JOHN C. D. HAY, Bart., M.P., R.N., examined.

1831. (*Chairman.*) You are the Chairman of the Iron Plate Committee, are you not?—Yes.

1832. (*Col. Taylor.*) From the experience which you have had in the number of experiments carried on against iron plates, having seen both Mr. Whitworth's and Sir William Armstrong's guns used against those plates, have you been able to arrive at any conclusion as to the comparative merits of those two guns for that particular object?—My impression has been, that whichever of the rifled guns has the most enduring power, and is capable of carrying the heaviest charge, and of throwing the shot with the greatest velocity, is the gun which will effect the greatest injury to the plate; and from what I have seen, those guns do throw shot of the same weight with the same velocity in any case in which the same charge has been used.

1833. Then, in fact, you consider that the injury done to the plates is almost entirely due to the work of the shot on reaching the plate combined with the material of which that shot is constructed, rather than to the gun from which it is fired?—Entirely so.

1834. Should you, from what you have seen of the working of the breech-loading gun, say that there

was any advantage attaching to that mode of loading or not, for heavy guns?—I think that there are certain advantages, if I could have the same confidence in a breech-loader that I have in a gun which is a muzzle-loader. My impression is merely a matter of opinion, and an impression which I have no better means of arriving at, probably, than any other person who has witnessed as many trials as I have. I think probably that up to the 40-pounder, breech-loading may be used with tolerable success; but I doubt whether, in the present state of the manufacture of the vent pieces of guns, the breech-loading apparatus is not of too delicate a nature to be considered as enduring and as trustworthy as a muzzle-loading gun, and the advantages which on ship board, and in case-mates, and elsewhere, would be derived from breech-loading heavy guns, I think are met, on the other hand, by the grave objection that there would not be the same confidence in that description of gun, and probably that the gun itself would not have those enduring qualities which ought to be expected of so expensive an instrument, and an instrument upon which so much will depend.

*Captain Sir J. C. D. Hay, Bart., M.P., R.N.*



1835. Admitting the possibility of divesting the breech-loading system of all danger, and all elements of deterioration, you would prefer the breech to the muzzle loader?—I would prefer the breech to the muzzle loader if I had the same confidence in it; but in giving that answer, I must say that I do not see any probability, in the larger class of guns, of making the present system of breech-loading so enduring as to make me say, with confidence, that in time of war I should prefer a breech-loading gun of large calibre to a muzzle-loading gun; there is, however, a system of breech-loading proposed by Mr. Westley Richards, now under trial by the Ordnance Select Committee, which may, I think, remove all the objections urged against breech-loading ordnance; but either the Armstrong or the Whitworth system is capable of muzzle-loading, as we know, and therefore the objection does not apply to the system at all, but to the fact of the breech-loading apparatus which may be applied to either class of ordnance.

1836. (*Col. Ormsby.*) Have you had any experience of the wedge system of breech-loading?—No; I have seen the system applied at Shoeburyness, under Colonel Taylor's directions, but I have no special information to give on the subject, which could not be elicited with more advantage from the officers who have had the special charge of it. There is one matter which, probably, I might allude to, as a matter of opinion, and that is, that the advantage of the Armstrong shot over the Whitworth shot appears to me in great measure to proceed from the fact, that the one is covered with soft metal and that in the other you have a projectile quite as hard, if not harder than the bore of the gun to which it is mechanically fitted; and I think it stands to reason, that the friction from that very hard metal rubbing over a softer substance must be more liable to wear out and to destroy the gun which is exposed to that friction than would be the case in a gun whose barrel is much harder than the shot itself. There were certain experiments (I do not know whether they have been brought to the notice of this Committee) at Woolwich not very long ago, with reference to the resisting power of different descriptions of rifled barrels, torsion being applied by mechanical agency to certain projectiles inserted into certain tubes, which were rifled in various forms. I cannot recollect exactly the figures which would have given the comparative strength of the different descriptions of rifling, but the Lancaster form of rifling, which is an elongated ellipse, a twisted oval, was the weakest, breaking at a strain of a figure which we will call 2, whereas the strongest was the old belted system, with two broad belts, which broke at a figure which I will call 2·8, and all the polygonal systems of grooving had different ratios in the interval between those two, the weakest being the Lancaster and the strongest being the old double belt. But when torsion was applied to the poly-grooved self-rifling weapon, in which there was interposed a soft metal between the hard metal of the shot and the barrel of the gun, I think it was never broken; it was infinitely stronger than any other system of rifling, in consequence of the interposition of the soft metal; and that would naturally appear to be so, because there is no pressure in a form to produce fracture. I thought that if you have not had those experiments brought under your notice, it perhaps might be worth your while to call upon Mr. Anderson, at Woolwich, who conducted them, to place them before you, as they contain some valuable evidence with regard to this subject. It therefore occurs to me, that whatever system of rifling is adopted, whether it be the Whitworth or the Armstrong system, a covering should be placed upon the projectile, which should protect the barrel of the piece from the effect of a hard material, which will inflict such an injury upon it as to wear out your artillery at a much earlier stage of their use than would occur if such a protection as is adopted in the Armstrong projectile were adapted to any rifled ordnance which might be employed.

1837. (*Col. Simmons.*) Are you aware whether any case has occurred of a gun of any particular form of bore splitting from an action of that sort with any hard projectile?—None has occurred in any presence, but I have understood that such have occurred, but abrasion of the interior of the tube has frequently occurred.

1838. That abrasion has tended to split the gun, has it not?—Not so far as I have opportunity of knowing, but it would have been obviated entirely by the interposition of a soft metal, which would protect the gun from the abrasion which occurs from the harder projectile rubbing very rapidly on the interior surface of a softer metal.

1839. Could you direct us to any accident which has occurred from a gun splitting from this effect of the projectile?—I rather think that the "Excellent" has had some experience of that description, but that evidence would come more directly from the officers of the "Excellent" than from myself. Captain Singer could probably bring evidence of that description much more readily than I could; I know that it has occurred, but that evidence would not be so valuable coming from me.

(*Commander Singer.*) The case you have mentioned occurred under my own eye.

(*Witness.*) Therefore either Captain Singer himself could give evidence, or he could direct the Committee to the best authorities for it.

1840. (*Capt. Preedy.*) In the present state of the Armstrong gun, would you recommend a portion of the Armstrong guns being supplied to the navy to be used as broadside guns, in rapid and continuous firing?—I have not been afloat for the last two or three years, and therefore I have not been in a ship with those guns. There are officers who have very lately been in command who would give better evidence than I could as to the desirability of such a step. I, myself, individually, would be very glad to have them as broadside guns in preference to any smooth bore ordnance, and I say so the more readily because I have recently seen an experiment which I was very anxious to see tried two years ago, which was the shortening of a 110-pounder shot, cutting it down till the cylinder weighed only 68 lbs. and then firing it with the service charge of 16 lbs. of powder from what is called the 100-pounder Armstrong gun; and the result of that was at short ranges a greater velocity than from the smooth bore, and also a power with the same gun of inflicting, upon an enemy's fleet or dockyard, at very much greater ranges than were ever contemplated, when the 68-pounder was a broadside gun. The great injury which we know could be effected by shells thrown with the bursting charge which that shell contained; therefore you have in the Armstrong gun a weapon capable of doing more with a smooth bore charge and weight of projectile than a 68-pounder can do; and it also has the capacity to perform the duty of the rifled ordnance at great ranges, and can also be used at any range over 200 yards with very much greater precision. I am now speaking of any rifled gun; I am not saying that I prefer the breech-loading Armstrong gun to the muzzle-loading Whitworth gun; nor am I at this present moment saying that I prefer the Armstrong gun to the Whitworth gun; I merely say that if my ship is to be armed with a gun of about the weight of five tons, I should very much prefer a rifled gun which is capable of performing the duty of a smooth bore gun, to a smooth bore gun which is not capable of performing the duty of a rifled gun.

1841. (*Major Young.*) It is not customary, is it, to have such heavy guns for broadside guns as a 68-pounder of 95 hundredweight?—No, it is not usual to have them so heavy, but if war is to be conducted afloat against iron-cased ships, it will be necessary to have them. You cannot limit the weight of your gun to anything very much under five tons, because as far as we know a 4½-inch iron plate placed upon any structure which is used to support it afloat is invulnerable to any smaller artillery, and

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therefore if you are to have artillery of that weight, you ought to have in each gun the capacity of performing both functions, that is to say, the function of a smooth bore, which it will do under certain circumstances, and the function of a rifled gun, which a smooth bore cannot be made to do. But I would say that that gun ought not in my idea to be a breech-loading gun; not because I do not think that a breech-loading gun is a better gun if it could be adopted with safety, but because I do not see my way as yet to a breech-loading gun which shall be as enduring as a muzzle-loading gun; therefore if the Armstrong system be the one that is adopted, I should prefer the muzzle-loading polygrooved gun upon the shunt principle, with ribs on the shot. If the Whitworth gun is the one that is adopted, then on the other hand I should prefer that the shot should be protected by some wrapper which should prevent the immense friction, which I think would destroy the tube of the gun much more rapidly than would be desirable in case of war.

1842. (*Capt. Preedy.*) Do you not think that the breech-loading system is attended with great danger on board ship?—No, I do not.

1843. Supposing, for instance, you were going into action at night, do not you think that in the confusion and excitement of beating to quarters, accidents might occur from not properly adjusting the vent pieces?—No, I do not think so. I have no fear about the vent pieces; either the one that withdraws or the other one which rests upon handles. I have no fear of a vent piece of that description, as far as its endurance is concerned, up to a 40-pounder, and I have no hesitation in saying that if the vent piece could be made as enduring as the breech of a muzzle-loading gun, I should infinitely prefer the breech-loading apparatus to the muzzle-loading apparatus; and that up to a 40-pounder, as I believe the present vent pieces can be made enduring, I prefer the 40-pounder breech-loader to the muzzle-loading 40-pounder, either for ship or land service, if I have the choice; I can say that without any hesitation.

1844. (*Chairman.*) And for boat service also?—For any service I should prefer the breech-loader to the muzzle-loader when I see my way to the endurance of the apparatus.

1845. (*Col. Ormsby.*) And you think you see your way to it up to the 40-pounder?—I think so. Of course that is a matter of opinion.

1846. (*Capt. Preedy.*) Do you think that the seamen themselves would have the same confidence in the breech-loading as in the muzzle-loading system?—I think that the men may be trained to be confident in anything if they are properly instructed. We remember the difficulty there was in introducing percussion locks instead of flint locks or portfires, and every change has been resisted, until by careful training the men have been shown that there is nothing dangerous in a new invention, and in the just application of science to war; and I do not believe there would be anything to shake their confidence.

1847. (*Mr. Pole.*) You mentioned the shunt gun; you have seen that fired against iron plates, have you not?—Yes.

1848. Do you think that that is a successful way of applying the principle of a soft-yielding material to a muzzle-loading gun?—From the very few experiments which I have seen it did appear to me to be satisfactory; that is to say, having a desire to see a soft substance interposed, and believing that in those large guns it was undesirable that there should be a breech-loading apparatus, it seemed to me to be a very safe method of applying the muzzle-loading principle to a gun of which the windage should be stopped up by the crushing out of the soft metal of the shot, and in which the soft metal should relieve the bore from the friction of the rifling process.

1849. Do you think that there are any other evils attendant on the use of hard shot besides the action

on the barrel of a close mechanically fitting shot of hard material; that is to say, do you see any danger in the loading, or any inconvenience from the loading on board ship?—No; I think that the accuracy of fit which Mr. Whitworth has given, and the relief which he has latterly given to the angles of his shot have done away with any difficulty in loading if the *sabot* is used to prevent the shot slipping out of the seat. I do not think that there is any very great danger to be apprehended from that. It would be more for artillerymen to say whether in the field there would be any liability to obstruction from sand, or the fouling of the gun causing any danger. Of course if there is obstruction, as there is almost sure to be, something must yield, and in any case it is desirable that there should be a soft substance interposed between the hard shot and the hard barrel.

1850. Something has been said about the rolling about of heavy shot on board ship when they do not fit firmly in the barrel; what is your opinion on that point?—It was stated that it would be impossible to be sure that the Whitworth shot remained home against the charge, that there was likely to be a vacancy between them, until he adapted this small *sabot*, I think he calls it, which is a wooden fork, which is inserted over the shot, and a tap of the rammer breaks it, and the two forks become wedges, and they fasten the shot in its place, therefore that objection does not remain.

1851. (*Capt. Preedy.*) Would not an ordinary wad do?—It probably would; but this is the system which I have seen adopted by him.

1852. (*Major Young.*) What is the limit of the weight of gun which a man-of-war ought to carry?—There is no limit but her displacement.

1853. You may have a gun of any size for a pivot gun, may you not?—Yes; I think Captain Coles has answered that question for us. You have the same power as a railway turntable has of carrying any weight you please, and by the mechanical contrivances which Captain Coles has applied to the turntable it renders it quite possible to use a gun carrying a shot of 1,000 pounds weight, if a ship will carry it, and it is necessary to carry a gun of that description.

1854. As far as the recoil is concerned you think that can be met?—Yes; I think that all those things can be met thoroughly, and that we have perfect power and control upon Captain Coles' system. There is a limit to the number, of course.

1855. (*Mr. Pole.*) Have you any remarks to make with regard to the nature of the projectiles to be used with those rifled guns, and the capabilities of the different guns for shell of different kinds?—No; my evidence probably is not so good as would be obtained from others whose attention has been specially directed to that subject.

1856. (*Col. Taylor.*) With respect to the Whitworth shell which you have seen driven through a ship's side by Mr. Whitworth's gun, do you consider that that shell has as yet attained what is desired in conveying a sufficient bursting charge through the side of a ship?—Not a sufficient bursting charge; but I think that Mr. Whitworth has gone nearer to it than any other person. Mr. Whitworth's principal merit at this moment is in having discovered a material which has sufficient hardness and sufficient toughness, and is capable of being converted into a hollow projectile, which shall pass through a given thickness of iron without being itself fractured by the blow. That is the point upon which other men as far as we have yet seen have failed.

1857. (*Col. Simmons.*) Is his hollow projectile the first which has penetrated an ironside ship?—It is the first which has conveyed a bursting charge through an iron plate of  $4\frac{1}{2}$  inches thickness; in all the other cases the shell itself has been fractured. Although it may have succeeded in breaking the plate the shell itself has broken up, and the charge has exploded outside.



1858. (*Col. Ormsby.*) Do you think that that is entirely owing to the sort of metal of which it was made, and not to the form of the shot?—Yes, it is entirely due to the description of the metal; to the excellent temper of the steel of which it was composed.

1859. (*Major Young.*) You do not attach much value to the flat-headed projectile as regards penetration, do you?—I think that there are certain advantages in the flat head under certain circumstances, if the flat part is considerably within the diameter of the bearing surface of the projectile. We have tried a variety of projectiles of different forms, and we have found that in all cases a perfect cylinder is a very bad form; it flattens itself out a little at the head, and requires a very much larger area to be broken through in order to allow the shell to pass. Mr. Whitworth contracts the flat end very much, so that if there is any bulging out at the end there is no more work for the shell to do than is necessary to allow the greatest original diameter to pass through. I may remark that we have had a good many experiments against plates at various angles, and we found that the Armstrong service shot bit as far as an angle of 60°, if I remember rightly, and then began to glance off; but it bit, and the plates had no resisting power,

The witness withdrew.

Captain RICHARD HARRISON, R.E., examined.

1863. (*Col. Simmons.*) You were with the force in China, which was employed against the forts on the Peiho, were you not?—Yes.

1864. In the course of those operations, did you witness the effects of the Armstrong guns?—Yes; I think I saw every shot that was fired by them against works, and against men also.

1865. Will you state where you saw them employed, and the effects which they produced?—I saw them first at the action of Sin-ho employed against cavalry, the first shot I think which was fired by them in China. I was not able to note how many they killed, but it is certain that they cut up a great many of the cavalry at a distance, I believe, of from 1,200 to 1,500 yards, and they had the effect of entirely routing the Chinese cavalry, who were coming on with great force at that time; they were very destructive.

1866. Had you an opportunity of seeing them fired against men, and actually counting the killed or wounded, from the effect of the shot?—I cannot exactly remember the numbers; but by one shot which was fired afterwards, at an action that we had near Pekin, I think there were as many as 13 killed. It was at a very long range (about 1,500 yards), and there were two or three horses, and, I think, 13 men killed at one single shot. That very much astonished the Tartars. Sir Hope Grant ordered it merely as an experiment, I believe. I was standing close by him when he ordered the gun to fire, and the Tartars were standing, as they thought, quite out of range.

1867. (*Major Young.*) You were certain that the effect was produced by an Armstrong shell?—Yes; there was no other gun fired.

1868. (*Col. Simmons.*) Was it a segment shell?—Yes; it was the regular one, with the concussion fuse.

1869. (*Col. Ormsby.*) Was there a heavy fire upon the guns at that time?—No; none of the Chinese guns could reach the battery.

1870. Did you see the Armstrong guns at any time exposed to a strong fire?—Yes.

1871. (*Chairman.*) When they were used against men, they were not under the influence of a heavy fire from the enemy?—Not under a heavy fire.

1872. (*Commander Singer.*) What description of ground was it where you saw this concussion shell act?—It was not hilly ground, but ground dotted over with small jungles, and villages, comparatively level; there were deeply-sunk roads and gullies here and there. You could see a good deal over the

which was greater than the right line which it had to traverse.

1860. (*Commander Singer.*) Do you mean 60° from the vertical?—Yes.

1861. (*Major Young.*) Against a vertical plate I suppose, there would be very little advantage in flattening the point at all?—None. From what we have seen, the only advantage of flattening the end of the shot appears to be that it bites at great angles.

1862. Was it 60° with the horizon, or 60° with the vertical?—60° with the vertical. We put a series of plates at 10°, 20°, 30°, 40°, 50°, 60°, 70°, and 80°, and down to the 60°; the effect of the Armstrong shot was to bite, if I remember right, but certainly at 45° it was to bite and to cause a fracture. An experiment indeed was made, in which a three-inch plate was exposed to the fire of the 40-pounder Armstrong at 200 yards at right angles, and was penetrated. The same plate was again exposed to the same shot at the same distance, but at an angle of 45°, and the plate received the same amount of damage, but in a more oval form. This and many other experiments with a similar and uniform result served to show that a plate at an angle does not materially increase its resisting power, even against conical-ended rifled projectiles.

country if you got on the top of a little mound, or of a house.

1873. When the shell struck, it struck in front of the horsemen?—Yes; and it burst.

1874. What description of ground was it where it struck?—A roughish field; not hard ground, it was dryish ground, very much like the ground might be just opposite this window.

1875. Not very uneven?—No, not very broken. This one shot was very much noted, because we had been fighting with the Tartars all the day, and they had halted in a place which they thought was quite out of range. Then Sir Hope Grant said he wanted to try the effect of one shot at them, and he ordered one gun to be fired, and the effect was very striking. Everybody was surprised, and the Tartars particularly so. There was a large body of 500, I should think, and it completely dispersed them. That was the most remarkable shot that I witnessed against men, and we all noted it.

1876. (*Col. Simmons.*) As to the effect of the Armstrong gun against earthworks, have you any experience upon that point?—The chief effect that I saw was against the village of Tang Ku. That was a large fortified village, and I have sections of the parapet here, if the Committee would wish to look at them. The guns were all brought up in line, and at a range of from 1,000 to 1,200 yards opened against the guns of the enemy. There were about 60 enemy's guns firing on the Armstrong batteries, and the other batteries which were brought up in line, and I noted where the Armstrongs guns fired. There was a battery of Armstrongs on the right. I have a section of the place where they fired at, and there were 16 or 18 gunners of the Tartars killed at one gun. The shells hit a small crenelated wall on the top of the parapet, about 3 feet 6 inches high, and 1 foot 3 inches to 18 inches in thickness, where they burst, and soon all the Chinese gunners were killed. We counted at one gun from 16 to 18 bodies.

1877. The effect was very destructive against those men who were concealed behind this parapet?—Yes.

1878. The parapet being very thin, and serving well for the explosion of the shells?—Yes; it was just sufficient to explode the shells. We saw where the shell struck the parapet and broke, that the men were all killed by the Armstrong shell. There were some, of course, in the line that were killed by other shell, but the ones that I noted were killed by the Armstrong shell.

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1879. (*Col. Ormsby.*) There were smooth bores there also, were there not?—Yes; all the batteries were drawn up in the same line.

1880. (*Col. Simmons.*) Was there a marked superiority in the effect of the Armstrongs over the others?—We thought so; when we examined the bodies, we saw bits of the Armstrong shell lying close to where the bodies were, and the wounds seemed to be by the Armstrongs. They opened first at 1,000 or 1,100 yards, and then they advanced to 600 yards, and they very soon subdued all the enemy's fire.

1881. (*Col. Ormsby.*) At this time were the Tartars firing much against you?—Yes, all their guns opened fire against us; but that lasted a very short time; the Tartar fire was not good, their shot went over our heads.

1882. Did you lose any men?—Yes; about 8 or 10, or something like that.

1883. (*Capt. Preedy.*) Did the Armstrong guns advance the same distance as the other guns?—Yes, they all went on in line; it was a general advance of the guns.

1884. (*Col. Simmons.*) Did you observe whether the enemy's batteries were shut up quicker opposite the Armstrong guns than opposite the other batteries?—I could hardly tell that; very soon the fire closed all along the parapet. One or two guns opened afterwards, a single Tartar would get up and load it, and fire it.

1885. You saw the Armstrong guns also fired at the other forts, did you not?—Yes; I saw them at the regular Taku forts. After we had taken that village to which I have referred, we attacked the Taku forts. It took us three or four days making batteries and so on. I have brought with me the position of the different batteries, to show where the Armstrong guns were used, and this is a little rough sketch of the fort, with sections (*producing the same*). Certainly the Armstrong guns, we all thought, were terribly effective, and they saved a great deal of loss on our side. Photographs were taken, showing how the bodies lay about inside. There were an immense number killed by the Armstrong guns.

1886. The Tartar gunners were protected in a sort of casemate or splinter proof, were they not?—Yes.

1887. Did the Armstrong projectile penetrate that splinter proof?—Yes, it penetrated the outside, and exploded on striking, which gave a very searching fire.

1888. (*Chairman.*) At what distance were the Tartar gingals effective?—That depends upon their elevation; they will go a great distance sometimes; it is quite a chance; it depends upon how their ball fits; they are such irregular things; they will sometimes go 2,000 yards; into some of their guns they will put any amount of powder, and fire them. When we were where we thought we were quite safe, and had bivouacked for the night, several of their shots went right over our heads, but they did not care how much powder they put into their guns; they would fill them up almost with powder, just to try to frighten us. I am quite sure that the great impression in the army was that almost all the effect this produced on the fort, as well as on the village of Tang Ku, was by the Armstrong guns. I am sure that the wounds were caused by Armstrong guns. I saw the segments of the Armstrong shells lying about just inside the casemates, and the wounds, you could see, were made by them. Sometimes you found a bit in the wound; you cannot mistake the wound. The only time I ever

heard anything like a complaint against the Armstrong guns was when all the guns were in position for the bombardment of the North Takoo Fort, and an Armstrong battery had to fire almost over the head of a mortar battery. Those in the latter complained of bits flying about their ears, and were rather afraid of being killed by their own guns.

1889. Did an accident ever occur from that cause?—I never heard of one; but whether it was that any of the shells burst at the muzzle, or whether it was only the effect of the shell going over their heads, I do not know; the battery was moved up closer.

1890. The battery from which this complaint issued was a battery of smooth bores?—It was a mortar battery. A great many of the staff stopped in that battery.

1891. Did you know of any belonging to the working parties being killed in that battery?—I never heard of it.

1892. Were there many at work?—Yes; all the time there were men at work at a bridge close to the battery to let the troops over; but I did not hear of any one of our men being killed from that cause, and I am sure I should have heard of it if it had been so.

1893. (*Commander Singer.*) Did any instance of the projectile penetrating the thick part of the parapet and bursting the parapet, come before you at all?—You could see that all the parapet was terribly cut about.

1894. Was it so thick as to prevent the penetration?—Yes; but you could see that it was much cut about. There were very good photographs taken of every part inside and out, and in every direction, of the fort that was fired at, from which you could judge of the effect. A very heavy shower of rain came on that night, and a great deal of the parapet, having been cut about so much, was washed down; and this prevented a long observation of the effect of the shells on the parapet.

1895. (*Chairman.*) What was the parapet formed of?—It was made of mud and all sorts of things, wood, and hides, and rope, and everything that they could build it up with, but chiefly mud; they mix straw with it and smear it over on the outside; so directly the crust is broken a little, if the rain come upon it, it soon destroys it; the crust is coated over with something to protect it.

1896. (*Col. Simmons.*) Of what calibre were those Armstrongs?—They were 12-pounders. They had a great deal of knocking about the first day that we got them out of Paetang, before that action which I mentioned against the Tartar cavalry. The road was all mud, in which we sank occasionally up to our middle, and every now and then the guns went tumbling about into it in the most terrible way. We had perpetually to take all the horses out and have planks laid down, and the men were working on them to get the guns out of the mud.

1897. Did not that render them unserviceable?—It did not seem to do so; they opened fire directly they were needed and went on firing all day.

1898. (*Chairman.*) What do you suppose was the greatest number of shots that they fired in any one day?—There is a record of that, I should presume, with the Artillery; I cannot answer that question; they seemed to fire without there being the least interruption. Whenever they were wanted to, they never stopped firing.

1899. Will you put in those sections which you have shown us?—I will have copies made and furnish them to the Committee.

The witness withdrew.

Adjourned.



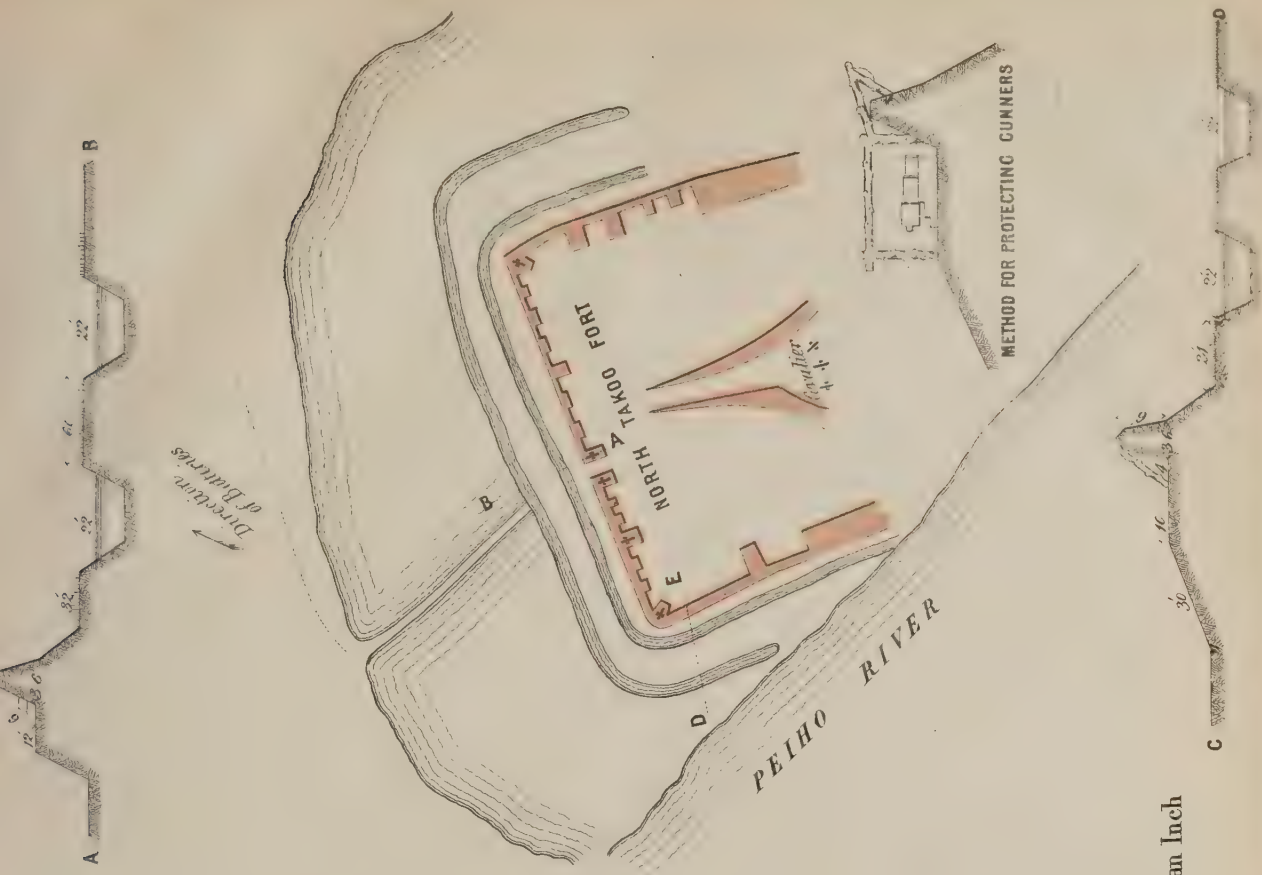
# ROUGH SKETCH

WITH SECTIONS OF THE ATTACKED FACES OF THE VILLAGE OF TANGKOO AND NORTH TAKOO FORT.

To Illustrate Cap<sup>t</sup> Harrison's evidence on Armstrong Guns.



Scale 400yds to an Inch







Monday, 16th February 1863.

PRESENT :

MAJOR-GENERAL RUMLEY, Inspector-General of Infantry.  
COLONEL ORMSBY, R.A.  
COLONEL TAYLOR, R.A., Commandant of School of Gunnery.

CAPTAIN PREEDY, C.B., R.N.  
COLONEL SIMMONS, C.B., R.E.  
COMMANDER SINGER, R.N.  
MAJOR YOUNG, Director of Artillery Studies.  
JOHN PENN, Esq., F.R.S.

SECRETARY :—CAPTAIN DYER, R.A., Assistant Inspector of Artillery.

MAJOR-GENERAL RANDAL RUMLEY IN THE CHAIR.

Captain EDWARD RICE, R.N., examined.

1900. (*Chairman.*) I think you commanded the "Algiers" in the Mediterranean?—Yes.

1901. Were you armed with any Armstrong or Whitworth guns?—We had no Whitworth guns, but we had three Armstrongs.

1902. Would you have the goodness to inform the Committee of any results of the practice connected with those guns that came under your observation?—We had not a great deal of practice with them; we fired 32 rounds, and we had the ordinary drill exercises.

1903. What sized guns were they?—One was a 110-pounder, and the other two were 40-pounders; the 110-pounder was supplied at Malta in place of a 95 cwt. gun which we had previously, and the same crew was put to the 110-pounder that had been attached to the other gun.

1904. As to the range and accuracy of practice, what was your experience?—We fired at distances of from 1,800 to 2,500 yards east of the Rock of Gibraltar. We took Sir William Codrington with us, and fired at objects in the rock, caves, and so forth. The practice was very good.

1905. Did any accidents occur?—No; there were no accidents during the time that the guns were on board the ship.

1906. (*Mr. Penn.*) Was the large gun a breech-loader?—They were all breech-loaders.

1907. And you had no difficulty with the screw stripping, or with the filling piece?—No; we had no difficulty.

1908. I think you state that you fired no more than 32 rounds?—We fired 32 rounds with two guns, 16 rounds a gun at Gibraltar, and 16 subsequently. The men who were captains of the guns were very good shots with the old smooth-bore guns, and therefore we were able to form a tolerably fair estimate.

1909. (*Capt. Preedy.*) Which gun did the men themselves prefer?—I think the old gun, the muzzle-loader.

1910. Do you know what reasons they gave for that preference?—I think they had always a certain sense of insecurity about the breech-loaders; the operation of loading is slower and more troublesome in the breech-loader than in the muzzle-loader.

1911. Do you find them as easily worked as the old smooth-bore gun?—No; the loading and pointing of the 110-pounder was slower than that of the 95 cwt. 68-pounder. In steaming quickly past a target, I do not think as many shots are fired with the Armstrong gun as with the muzzle-loader.

1912. Do you think that the sighting of the gun had anything to do with that, or was it merely the working of the gun?—I think it was due partly to the comparative slowness in the loading, and partly to the sighting.

1913. (*Col. Simmons.*) What was the weight of your 110-pounder Armstrong?—82 cwt., speaking from memory.

1914. Was it much about the same as the other?—No; the other gun is 95 cwt.

1915. (*Capt. Preedy.*) Do you consider that there is less liability to accident to the gun's crews with the rifled breech-loading gun than with the old smooth-bore muzzle-loader?—There is no danger in loading a breech-loader in my opinion, and certainly there is

some danger in loading a muzzle-loader. In firing I think the liability to accident is with the breech-loader.

1916. Do you consider that the projectiles for the Armstrong gun being coated with lead is an objection to their use on board ship?—So far as my experience goes, that is no objection.

1917. (*Major Young.*) You did not find the shot alter their shape at all by rolling on deck or in the transport?—No; we took care that they did not roll; they were kept in racks where they could not move, and in boxes, and the decks were carefully fitted for them. If Armstrong shot were stowed as spherical shot are they would be injured.

1918. You never found any of the shot too high for the chamber?—No, never.

1919. (*Capt. Preedy.*) Have you ever found any difficulty with the men in handling the vent piece; has there been any objection made as to the weight of it?—I do not remember any objection made by the men specially to that; but the weight of it in the 110-pounder, and the amount of work which is to be done, makes the operation slow.

1920. (*Col. Taylor.*) You did not keep any accurate record of time loading, did you?—No.

1921. How long had the crews of those guns, of which you have been speaking, been at the Armstrong drill, before they did this; had they been in the "Excellent"?—Some of them were marine artillerymen, and they were all drilled at the Armstrong drill, but I do not know what former training they had received.

1922. (*Col. Simmons.*) Is the difficulty of loading in a heavy sea much increased, in consequence of the weight of the vent piece; does not it retard the operation very much?—I never tried it in a heavy sea. If the lateral motion was violent, and the gun was pointed to the broadside, it would increase the difficulty. The weight of the vent piece in the large guns is a disadvantage.

1923. (*Capt. Preedy.*) Do you not consider, that in working the Armstrong gun in a seaway, it would be better handled and perfectly secure during the operation of loading, when a smooth bore could not be so; that is to say, that the gun would be loaded in its place, and keep against the ship's side, whereas you must run a muzzle-loader in to load it, and, of course, you have then to trust to the tackle and the breeching?—Yes, I think there would be an advantage, in that respect, in the breech-loading.

1924. Have you had any experience of the fuses supplied to the Armstrong guns?—All the shells that were fired burst.

1925. Did you find the time fuses right?—Yes.

1926. How long had you the fuses on board the ship?—They were on board 12 months; half of the practice was about a month after receiving them.

1927. Supposing a muzzle-loading gun could be obtained as effective in every way as the breech-loader, would you prefer it?—I should prefer it to any breech-loader that I have seen. I do not mean to say that I should prefer it to any breech-loader that may be produced hereafter.

1928. (*Mr. Penn.*) Did I rightly understand you to say, that there is more danger in firing a muzzle-loader

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than in firing a breech-loader?—I said that there was more danger in loading a muzzle-loader than in loading a breech-loader; I do not think that any danger arises in breech-loading.

1929. Did your remark apply to the danger to the men loading the gun, or to the gun itself?—To the men who are actually loading the gun; if there is any flannel remaining in the gun, the men are liable to have their arms blown off.

1930. There would probably be some danger with the Armstrong gun if the vent piece were not in, and the charge ignited, as far as the men were concerned, would there not?—Yes; but the risk of the charge igniting is very small.

1931. (*Commander Singer.*) Did you experience any inconvenience from the intensity of the recoil in the Armstrong guns?—No; we never fired with rapidity.

1932. What charge did you use with the 110-pounder?—The 12 lbs. charge.

1933. (*Col. Taylor.*) Did you fire solid shot from them?—Yes, 16 rounds.

1934. (*Commander Singer.*) The recoil was perfectly controllable, was it not?—Yes, the recoil is sharper with the 110-pounder than with the 95 cwt. gun, but still quite controllable.

1935. With respect to the 40-pounder what carriages were they mounted on?—On common deck carriages; we liked those guns very much. I would rather have the 40-pounders than the 32-pounders of 45 cwt. which they replaced.

1936. Did you consider the recoil sharp there?—No.

1937. Did you have the 8-inch breeching?—I do not recollect the size of the breeching.

1938. (*Col. Ormsby.*) Was the effect of the shot as great with the Armstrong as with the other gun; had you any means of judging of that?—We had no means of seeing the effect of the shot or the shell.

1939. (*Capt. Preedy.*) If you were appointed to a ship to-morrow, and you had the choice of pivot guns, would you choose the 95 cwt. smooth-bore gun or the Armstrong gun?—If I had two pivot guns I

should take one of each; if only one I should take the Armstrong gun.

1940. (*Col. Taylor.*) I should like to ask you what your feeling is with respect to the value of accuracy; do you or do you not consider that the element of accuracy in a gun is of value beyond all calculation from its moral effect; that is to say, if you were to come into action with another vessel and she were to find that you could hit her very much more frequently than she could hit you, do you think that the result would be greater than would be due to the actual practical difference between the two vessels?—Yes, but I think that the element of great accuracy at a long range is of less value in sea service than on land. I think that you may lose in a gun made for naval purposes important advantages by insisting on extreme accuracy, because, owing to the moving platform, the same accurate practice cannot be made at sea as on land. It is necessary for exceptional cases to have a limited number of long-range accurate guns, but I think for naval purposes a heavy blow at a short distance is the main object.

1941. (*Commander Singer.*) In fact for a broadside gun you would not sacrifice rapidity of fire to accuracy?—Certainly not; but accuracy is a relative term. For instance, I think that the 95 cwt. gun is sufficiently accurate for a broadside gun. But there are other equally important objects.

1942. (*Col. Simmons.*) You stated, I think, that you preferred the 95 cwt. gun to the 110-pounder Armstrong gun as a broadside gun, but that you preferred the 110-pounder Armstrong gun to the 95 cwt. gun as a pivot gun?—Yes, I do prefer the 68-pounder to the 110-pounder, with the present 110-pounder solid shot, as a broadside gun, because, at short ranges, the 68-pounder has a higher velocity, and has the advantage of simplicity, being a muzzle-loader. But as a pivot gun, the 110-pounder is desirable from its range, accuracy, and the capacity of the shell.

1943. (*Mr. Penn.*) Have you had any experience with the Whitworth gun?—None whatever. I have not had any one of Mr. Whitworth's guns in my own ship.

The witness withdrew.

Adjourned to to-morrow at a quarter-past Eleven o'clock.

Tuesday, 17th February 1863.

PRESENT :

MAJOR-GENERAL RUMLEY, Inspector-General of Infantry.  
COLONEL ORMSBY, R.A.  
COLONEL TAYLOR, R.A., Commandant of the School of Gunnery.

CAPTAIN PREEDY, C.B., R.N.  
COLONEL SIMMONS, C.B., R.E.  
COMMANDER SINGER, R.N.  
MAJOR YOUNG, Director of Artillery Studies.  
JOHN PENN, Esq., F.R.S.

SECRETARY :—CAPTAIN DYER, R.A., Assistant-Inspector of Artillery.

MAJOR-GENERAL RANDAL RUMLEY IN THE CHAIR.

Captain HENRY C. GLYN, R.N., examined.

1944. (*Chairman.*) I think you have lately been on active service in New Zealand?—Yes, I have.

1945. Had you any Armstrong or Whitworth guns with you?—One Armstrong.

1946. What sort of gun was it?—It was only a light 12-pounder.

1947. Will you describe to the Committee what its advantages or defects were, or anything resulting from the practice?—I left England in 1860, and the ship was specially fitted out for the crisis in New Zealand; and we were ordered by the Admiralty to be fitted with this gun, with the idea of landing in New Zealand, and for boat work. It was the first Armstrong gun of any sort supplied to the navy. We were sent to Plymouth, and had to go through a

long course of drill with the men; there were a certain number of officers and men picked out, four or five officers of the ship, myself, and 18 of the best men were sent on board the "Cambridge," and went through a three weeks' course with all the guns, the 110-pounder and the 40-pounder; but when we got to New Zealand, the crisis was very nearly over, but we never landed with the Armstrong guns; the other guns that were used before were the 32-pounders and 24-pounder howitzers. And the experience that I had with our Armstrong gun, as a boat's gun, showed that it was perfectly useless, for three reasons :—First of all, it was much too long for the boat, (not for the carriage of the boat, but the boat itself,) which necessitated our using only 10 oars out of 14. Secondly,

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though the men had been well trained, and on board ship made very fair practice with the gun, in a boat they did not retain that accuracy of aim, because there is always continued motion in a boat. And, thirdly, in landing (which we had to do very often) on a rough beach, we found the greatest difficulty in transporting the gun from its boat's carriage on to its field-piece carriage, and in bringing it up on the beach. Commonly, in the navy, if you have any difficulty in the way of surf you put a hawser on the gun, and throw it overboard, hauling it up on the beach; but that you could not do with the Armstrong gun. Finding that the ship's boats were very likely to be much employed in this sort of duty, I made application to the commodore on the station to supply me with a 12-pounder howitzer, which would have been the gun that we should have had if we had not been supplied with this gun, with the view of keeping the Armstrong gun for use in case of landing with the marines, and it was supplied accordingly.

1948. (*Col. Ormsby.*) What was the difficulty that you had about landing the gun?—First of all, the bolts and the screws are very apt to get lost. The howitzer speaks for itself; you can throw a howitzer into the water, and do anything with it; there is nothing to look after except the tangent sight.

1949. There is nothing particular to look after in the Armstrong gun, is there?—There are the sights, vent piece, breech screws, &c., &c.

1950. Did you throw the Armstrong gun overboard?—Yes, but I did not give it a fair trial, because there was no surf at the time. I cannot say that there was anything lost; but one can only judge of that on service, if you have an enemy to meet on the beach and are in a hurry.

1951. (*Capt. Preedy.*) Do you know the length of the gun that you were supplied with?—I cannot exactly remember.

1952. Was it the same gun as is now supplied?—No, it was not; it was the first gun supplied, and it was about seven feet long, speaking from recollection.

1953. Had you been supplied with a shorter gun, should you have had the same difficulty to contend with?—I think not; as far as the boats were concerned, and the men's rowing.

1954. Do you think that it was as much the fault of the carriage as of the gun itself?—No, I do not think so; it was the ordinary 12-pounder carriage for sea service.

1955. (*Col. Ormsby.*) Did you find a great facility in having a breech-loader and not a muzzle-loader in the boat?—No, decidedly not; that is one of my objections against the breech-loader in boats. I consider that it is perfectly useless, for this reason, that the boat's carriage is raised, and the man has to stand behind it, and his back is brought against the two men who are rowing next him. In the case of a muzzle-loader, he stands upon the side of the foremost thwart, and the men who load the gun are men who would be pulling the bow oars in the boat, so that they are in a position to load the gun without laying in any additional oars for the purpose of loading.

1956. Do you think that a man in loading a muzzle-loader is more or less exposed than in loading a breech-loader?—He must be more exposed.

1957. (*Capt. Preedy.*) Would you prefer a breech-loader to a muzzle-loader for a naval gun?—No; I think that no gun is so suited for all services as a howitzer.

1958. But I mean combining the field gun with the boat gun, which is the usual gun on board ship?—I think that what you gain in the one you lose in the other; because the great thing is facility in getting your gun from the boat to the beach, which you lose in the breech-loader.

1959. (*Commander Singer.*) If I rightly understood you, you saw no practice with the 12-pounder Armstrong?—We had a great deal of practice, but no service.

1960. (*Col. Simmons.*) In the practice that you had with the 12-pounder, did you meet with any

accident; was any vent piece ever blown away?—None at all; no vent piece was blown out at all. There was an accident in a ship in New Zealand; but I think that Captain Seymour would be able to give you a more full account of that than I can.

1961. (*Capt. Preedy.*) Were you supplied with any other Armstrong gun?—None at all; they were going to give us a 40-pounder, but they did not do so.

1962. Did the men themselves offer any objections to this gun as a boat gun?—No; I do not think they did.

1963. (*Mr. Penn.*) Had you very much practice with the gun?—A great deal.

1964. Have you any idea how many rounds were fired with it?—I should think 150 or 200 rounds.

1965. (*Col. Ormsby.*) Was that against the enemy, or was it target practice?—Entirely against a target; we never went into action with that gun.

1966. (*Col. Taylor.*) You state that the man loading at the breech was inconvenienced by coming in contact with the two nearest oars, how did you manage with the recoil of the gun?—The gun is on a long slide.

1967. But the slide comes back between the oars, does it not?—Yes; the slide comes back between the oars, but the man is on one side of the slide.

1968. (*Capt. Preedy.*) You are obliged to bring a muzzle-loading gun in for loading, and then it comes in the way of the oars, but with an Armstrong gun you may keep it out the whole of the time, therefore it remains out of the way of the oars longer than the other would?—We found that we could not use our gun comfortably, and pull the four foremost oars, and both Captain Seymour and myself tried it very often. In a 14-oared boat we never could use more than the 10 oars, on account of the length of the gun.

1969. Could that difficulty be got over by introducing a shorter gun?—Perhaps so; the gun that we had was the first 12-pounder. It was full length.

1970. (*Commander Singer.*) In fact the slide of the Armstrong gun is the same as the slide of the howitzer now?—Yes; I do not think there is much difference in the slides.

1971. (*Capt. Preedy.*) Have you anything to complain of in the ammunition, the shot or shell?—No; I do not think we have.

1972. Did you find no difficulty in loading from the lead being stripped?—There was a great deal of stripping that we could not account for, because the ammunition was kept very carefully.

1973. (*Col. Taylor.*) With regard to the stripping off of the lead, what do you think is the furthest distance that you ever saw a fragment of that lead strike on the water?—I should say speaking approximately 300 yards; but I speak with all caution, only judging of the distance by the eye, when firing at a target at 2,000 yards.

1974. (*Col. Simmons.*) Was that shell fired from any height?—From about the height of 20 feet from the deck of a ship.

1975. (*Capt. Preedy.*) Has there been any delay with the Armstrong gun in manning the ship's boats, and sending them off from the ship?—None at all. I must say with regard to that, that the simplicity of the ammunition makes you more speedy in manning and arming your boats, because where before you had two or three sorts of ammunition to put in the boat, now you have only one, the segment shell.

1976. (*Major Young.*) Did you use both descriptions of fuses?—Both the concussion and the time fuses.

1977. Did they answer well?—I cannot say that they answered so well at close distances; in rapid firing the men were very often flurried, and I think that if there had been an enemy on the beach, and you were firing at 300 yards, you would have produced more effect with case than you would have done where the man had to adjust the fuse, because, although a trained man, I very often found that he was flurried in quick firing in adjusting the fuse. We tried it in competition with the howitzer for that very purpose.

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1978. And you found that they were quicker with the howitzer?—Much quicker with the howitzer, and that was one of the chief reasons which influenced me in making up my mind in favour of howitzers as boat guns, because when you attack a beach it is rarely that you can get a range of over 200 yards, and you can fire double case at 200 yards.

1979. You cannot get boat practice at much over that range, on account of the motion?—Just so; there is always motion in a boat, more or less, and then the moving on the thwarts at once renders the aim uncertain.

1980. Did you have any shells burst prematurely, or in the gun?—None at all.

1981. (Commander Singer.) As you have in the navy to combine boat service with land service, would you prefer still the howitzer for both services, or would you put up with the inconvenience of the rifled gun in the boat in order that you may have a good gun on land?—I prefer the howitzer for both services. I may be wrong in my opinion, but I think that the howitzer, and, certainly the 6-pounder smooth bore, on our naval carriages, and dragged by men, are more easily handled, than the Armstrong 12-pounder on its carriage. Of course I mean on a carriage which is dragged by drag ropes and men. It is more easily turned.

1982. (Capt. Preedy.) Is not that more a question of carriage than of the description of the guns?—Yes, entirely. The carriage must be made to suit the gun; but of course that is a very small question. A gun which could be dragged by men could never be used with a very long range at sea. I do not see what you want with a long range for boat guns.

1983. (Col. Ormsby.) Do not you think that the

superior accuracy of the Armstrong gun over the smooth bore is a great advantage in a boat?—Not in a boat; I do not think up to 500 yards you have more accuracy with the Armstrong than with the other gun.

1984. (Commander Singer.) In point of fact you consider that in a boat you cannot appreciate the great accuracy of the Armstrong gun?—No; in fact it is like putting a rifle in the hands of a ploughboy.

1985. (Mr. Penn.) Do you find the shot suffer from being carried about in the boats?—No, not in the boats. I think that, generally speaking, the shot did strip a little.

1986. (Major Young.) You never found the shot too high to fit the chamber of the gun?—No, never.

1987. (Commander Singer.) I think you stated that you never had an opportunity of seeing the effect of the shell against the enemy?—No, never.

1988. Did the intensity of the recoil in the boat appear to be inconvenient?—No, I think not; it was much the same as with the howitzer.

1989. (Mr. Penn.) Did you find any inconvenience from the lead stripping from the shot?—There was some stripping. I cannot say the exact distance at which we saw the stripping drop, because it was on the water, so that we were not inconvenienced by it.

1990. (Col. Taylor.) Do you remember by what process lead was fixed on the shell; when were they issued to you?—They were issued in 1860; they were some of the first that were made, and the lead was fixed by the old tin process, but there has been much improvement since then.

The witness withdrew.

Captain FREDERICK BEAUCHAMP SEYMOUR, C.B., R.N., examined.

Captain  
F. B. Seymour,  
C.B., R.N.

1991. (Chairman.) You commanded on the station in New Zealand, did you not?—Yes, I commanded the naval brigade landed there between April 1860 and April 1861, with the exception of a short interval, during which Commodore Loring, C.B., held the command.

1992. I believe you had some experience in the practical working of Armstrong guns?—I saw the Armstrong guns worked the whole time, and almost every shot that was fired from them.

1993. Had you any Whitworth guns with you?—We had none. I will mention what guns we had in action when the Armstrong guns were being worked. The Armstrong guns were brought into action on the 15th March 1861, having been landed 48 hours previously; and the last shot that was fired from them was on the 19th of March. The practice was not continuous, as there was no necessity for it; the guns that were being worked at the same time were two 10-inch and two 8-inch mortars, one brass 9-pounder field gun, and two 8-inch naval guns, 52 cwt. We were attacking a pah, working up to it by trenches, and the distance from the muzzle of the Armstrong gun to the pallisading of the pah, so far as I could make out, was 780 yards. I was working one of the 8-inch guns myself a good deal, that is to say, I was laying the gun and firing it, and that was the distance I gave. I have seen a report by Captain Mercer, of the Royal Artillery, who commanded the Armstrong battery, and I am only expressing the feelings of the officers and men of the three regiments of the line and of the naval brigade engaged there when I say that we by no means concur in Captain Mercer's statements in his report. We were all most anxious for the success of the Armstrong principle; we had also heard of what it had done in China, but I cannot say that the practice was as satisfactory as we hoped it would have been; I mean from the 12-pounder 8-cwt. guns. I recollect particularly calling the atten-

tion of Lieutenant Pickard, commanding one of the guns, to what I may call the want of success of the firing from his particular gun on one occasion, and he accounted for it by saying the reason was that the ground was so soft that the right wheel of the gun sunk deeper than the left; on which I remarked that that sort of thing must always occur on service; it was impossible to lay down platforms for field guns, and, therefore, I thought the instance we were then seeing was a very fair test of what the Armstrong guns were. I do not think that the practice from that battery was more accurate than that from the brass 9-pounder field gun worked by the Royal Artillery; the range, of course, was considerably greater when it was wanted. There is also one point with which the practice in New Zealand had nothing to do, to which I will allude. On the 6th of March 1862, having previously had reason to believe that the Armstrong shot stripped a good deal, I landed two 12-pounders 8-cwt. Armstrong guns on Garden Island, Port Jackson. The wind was blowing across the range very lightly indeed, and we fired 14 rounds at 1,370 yards. Out of those 14 rounds three shots stripped in such a way that it looked more like canister falling on the water than anything I ever saw before. The shot had been carefully kept in the boxes in which they were supplied, and no reason could be assigned that I know of for their stripping in this way. My reason for doing this was that one day when I was in the sap, working up to the pah of which I have spoken previously, something came down about my head that I knew came from behind and not from the enemy's pah, which I believed was the stripping of the Armstrong shot, and I think such stripping is very dangerous when you are firing over your own men at an enemy.

1994. At what distance were you from the guns in your rear at that time?—We worked up to within about 80 yards of the pah, and I think we were then about 120 yards, therefore taking 120 from 750 it was about 630 yards distance.



1995. (*Col. Ormsby.*) When you fired those 14 rounds, at what distance from the gun did the shot strip when you saw it on the water?—I should say about 140 or 150 yards, or from that to 200 yards; it was irregular. But I should here remark that all the shot that did strip were fired from the "Miranda's" gun, the 12-pounder. The "Harrier's" shot did not strip at all, and yet they had both been kept in the same places, namely, in the boxes in which they were supplied. I should like to mention one other point with regard to my own experience with the Armstrong gun. In September 1861 I sent the "Harrier" up to the "Fijis" with orders to the commander to levy a fine on the natives of a large town there who had been guilty of some malpractices with reference to British subjects. I told him that if they did not pay up at once, after a proper time had been allowed them, he was to burn their town. He did so, but previously to setting the town on fire he very properly commenced to clear the natives out of it by shelling the town. In one of the earlier rounds that was fired from the gun, I think it was the third, the vent piece came out, and the gas very severely burnt Mr. Pritchard, the English consul, who was in the boat at the time, and it wounded the No. 1 at the gun so badly that he had to be invalided with the loss of an eye, and slightly wounded Mr. Sedmond (who was in command of the boat) and five other men. The consequence of that, in my opinion, was that the men in the "Harrier" lost all confidence in that gun. I have no doubt whatever that they would have done their duty about working it in a boat afterwards, but it is a thing which I should not have liked to have ordered them to do. I would have done it, of course, if it had been necessary. I would now beg leave to read a letter which I received from Sir Malcolm McGregor. I asked him for further information on the subject, and this is an official letter from him:—

"Harrier, Auckland, 7th December 1861.

"SIR,—Referring to my letter of proceedings dated 8th November 1861, in which I mentioned that the vent piece had been blown out of the Armstrong gun, I have the honour to inform you that, upon reflection and inquiry, I can only arrive at the conclusion that either the cartridge was not quite home or that something prevented the vent piece from dropping close down into its place. I myself heard the cams tap, and the sound appeared correct; although the cone could not have been accurately in its seating, the breech screw must have been very tightly screwed up, because the shot was projected, and therefore the vent piece must have stood a very severe strain before quitting its place. Captain Strover, R.A., when he came on board to examine the vent of our broadside guns, told me that a similar accident had occurred on two recent occasions to the Armstrong guns of the royal artillery (in New Zealand). As at present fitted I have no doubt when in its proper place no accident can occur, but the smallest inaccuracy, so as to be almost imperceptible, is likely to be attended with serious consequences. With a view to rendering accidents less frequent, I would suggest whether it would not be possible to fit the vent piece in such a manner that if it were not properly screwed up any one would immediately observe it.

(Signed) "MALCOLM MACGREGOR,  
"Commander."

1996. Had you any other guns besides 12-pounder Armstrongs?—I have never seen any Armstrong guns out there except 12-pounders and the 110-pounder on board the "Orpheus," the ship which relieved us. I would say that on the occasion of the Armstrong guns being brought into action, of course it was a novelty and everybody was most anxious to see what really was the effect of their practice, and we had heard so much about them that we expected to see something very wonderful, much more perhaps than we had a right to expect. I will give the Committee an instance to show that the firing was not better than that from the 8-inch gun of the navy. About 10 days before the incident to which I am about to allude occurred the

enemy had made a sortie one night and carried off the sap roller at the head of the sap, and damaged the sap considerably. They stuck up the sap roller across the only place where we could have got into this pah, and on one particular occasion, as they were excavating a rifle pit behind it, General Pratt, who was in command, was most anxious to knock them out of it if we could. The 8-inch gun was mounted in the redoubt at the distance I have described from the pah, and close to it was an Armstrong gun, a 12-pounder. I used to think that I could fire as well as most of our men at all events, but I put one of the best shots we had, a seaman gunner, at our 8-inch gun, and he fired three rounds and I fired three rounds out of the 8-inch gun, and we did everything except hit it, and we had six or eight rounds or more from the Armstrong gun with equal want of success.

1997. (*Col. Taylor.*) When you say that you were firing at the sap roller, at what range was it?—About 750 yards.

1998. You could not expect so small a projectile as a 12-pounder to produce any great effect?—But they never hit it, nor did we with the 8-inch gun; everybody in the whole camp saw it, and the men in the redoubt; the old battery of artillery were of course all in favour of the old guns.

1999. (*Col. Simmons.*) Had you any difficulty with the breech screw of the 12-pounder?—None at all that I ever saw.

2000. Was there no stripping of the screw?—No, I never saw any. The great difficulty with regard to the Armstrong gun, I think, is in rough work owing to the screws and the quantity of gear that you have about it. Taking it for boat work you never could land that gun through a surf. Supposing there had been a heavy surf on the beach at the landing in the Crimea as there was on the last day, and you had had Armstrong guns, you would have found it very difficult to land them uninjured, when you consider the breech piece and the screw and everything belonging to it.

2001. (*Capt. Preedy.*) Would you not in such a case remove the screw from it and everything else that you could?—But even after you have removed all you can from it, it is much more liable to injury, and there would be greater difficulty in landing it uninjured.

2002. (*Col. Simmons.*) Had you occasion to land your guns often in New Zealand?—The most difficult job we had was landing the heavy guns, because all along that west coast of New Zealand it is one continual line of surf; there is no such thing as a harbour, except in one instance, and that is a large estuary miles away; but during the whole series of operations there was a heavy surf, and one may imagine what was the difficulty of landing the 8-inch guns there under such circumstances. However, we were very well off in that respect with regard to the Armstrong guns, because we took them ashore upon a very fine day—one of the finest days that we had—and they were brought on shore in regular surf boats.

2003. (*Capt. Preedy.*) Were the guns found to be injured in any way after the service that you had with them?—No, not that I am aware of; I should say certainly not. There was the utmost care taken of them, no men could be more careful of them than Captain Mercer and the whole of the officers and men under his orders.

2004. (*Col. Simmons.*) Did you use segment shells against this pah?—We fired every projectile that we had.

2005. Did the segment shells appear to be very searching in their fire, that is to say, did the fragments appear to you to search into the rifle pits and holes more than ordinary shells?—My only reason for thinking that that might be the case is what I have seen of the effect of segment shells in the instance which I mentioned when we were firing for practice. I should imagine that they must have done so.

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2006. Did you assault this pah eventually?—No, there was an armistice on the 19th of March, which ended in the Maoris evacuating the pah and retiring from their position in our front.

2007. Had the natives any rifle pits?—Yes, and latterly so close that we ran a parallel from our advanced trench into their advanced rifle pits.

2008. Did you find the Armstrong projectile very effective in turning them out of those rifle pits?—No, I should say that the Coehoru mortars were very much more effective than anything else. I went into the rifle pits that we worked into and I found numbers of pieces of the Coehoru shell in them.

2009. Do you know whether the artillery use both the time and the percussion fuse?—I know that they did.

2010. Did they burst the shells generally by the time fuse or by the concussion fuse?—By the time fuse; but I know that they used the concussion fuse, because in front of the pah there was a line of rifle pits which had been made out of an old ditch that was there, and Captain Mercer was trying to drive a shell through the earth so as to burst with the concussion inside the rifle pit.

2011. Did he succeed in accomplishing that object?—To a certain extent I think he did; we saw that there was inaccuracy in the practice, because we saw the shell go both high and low every now and then.

2012. (*Commander Singer.*) Had you any means of knowing the effect of the shell by examining the pah after it was evacuated?—I cannot say that we had; I was not in the pah after it was evacuated. I saw many of the 40th who were there, and I am certain that I am expressing their opinion in saying what I do now. Captain Mercer himself formed a very different opinion, and the Committee will find his opinion in the artillery papers. I saw his report in Sydney in March 1862, and it must have come out about December 1861.

2013. (*Capt. Preedy.*) In the reports which you may have received from officers serving under your command in New Zealand have any important objections been raised to the Armstrong gun?—When I have been talking with them, I think the only objection has been the danger of the vent pieces coming out. They all knew of the accident which occurred on board the "Excellent," and they naturally said to themselves, "Suppose this were to happen in action on the main deck of a man-of-war, the consequences would be very serious."

2014. You do not think that they gained confidence in the Armstrong gun?—I think not. That is a subject which I would never talk about with the men, because I think it had better be let alone; but I have talked about it repeatedly with the officers.

2015. (*Col. Ormsby.*) From what you have seen, would you prefer on board a ship the muzzle-loader to the breech-loader?—Yes, for the reason which I have just mentioned.

2016. But if that reason could be overcome, and if the vent piece could be made perfectly secure, would you then prefer the muzzle-loader to the breech-loader?—I have never seen an Armstrong gun fired between decks, and therefore I cannot speak from personal knowledge. The smoke which comes from the breech when the vent piece is taken out, I should consider a very great objection. I have been told of that objection by a lieutenant who was serving with me three years, and is now on board the "Emerald," in which ship he commanded the midship quarters on the main deck where there were four Armstrong guns mounted. But on that subject, Captain Preedy and other officers of ships where Armstrong guns have been mounted on the main deck, can give much better information than I can.

2017. Do you think the 12-pounder a good gun for a boat gun?—No, it occupies too much room.

2018. (*Capt. Preedy.*) You are speaking, I presume of the first gun that was supplied—the long gun—but they have been very much reduced in length. Do you think that that would get over the dif-

ficulty?—Yes, to a certain extent, it would. If I were working the gun myself, I would prefer having the 12-pounder howitzer. I inspected the "Miranda" in May 1861, and she had a 30-foot pinnacle, and four oars were disabled by the Armstrong gun; and, for that and other reasons, I ordered the 12-pounder howitzer to be supplied from the "Niger," which was then going home; and that gun was worked as a boat gun ever afterwards, unless I gave orders to the contrary. And, for the same reason, after the accident occurred on board the "Harrier," I supplied her with a 12-pounder howitzer as well, and her boat being only a 28-foot pinnacle it was more lumbered up by the 12-pounder Armstrong gun than the "Miranda's" was, which was two feet longer. I took the "Miranda" and the "Harrier" outside Sydney Heads in March 1862, and we practised at all sorts of ranges with a long ground swell running, and the ships in considerable motion. I do not think that the practice from the Armstrong gun then was in any way more accurate than that from the 87-cwt. 68-pounder and the 45-cwt. 32-pounder, though it was more so than that from the 32-cwt. 32-pounder; but that of course might be owing to the difference in the captains of the guns.

2019. (*Col. Simmons.*) Was this practice always carried on with the 12-pounder?—Yes, we always used the 12-pounder at general quarters in the Miranda. There was a gun's crew told off for it, who had been drilled in the "Cambridge" for that purpose.

2020. You would not expect such great accuracy from the 12-pounder as from the heavier guns that you have been speaking of, would you?—That depends on what distance you are firing at.

2021. (*Col. Ormsby.*) Do you remember what was the extreme range which you fired at on those occasions?—The extreme range was 1,800 yards.

2022. Did you find the 12-pounder not as accurate as the heavier guns at that range?—I do not think they were. I think that the solid shot 68-pounder was the best gun there.

2023. (*Col. Taylor.*) The 12-pounder was laid, I presume, by the regular sights, the side sights, and not by the ratchet sights?—Yes; by the side sights.

2024. Do you not think that at first a man accustomed to laying by the line of metal sights, especially on a moving deck, and firing at an object far off, would be puzzled by having to lay the gun by the ratchet sights?—Yes. I wish to make every allowance for that. The Committee will understand that no person could wish more for the success of the Armstrong gun than I did, and still do; but it is my duty just to say what I have seen.

2025. (*Capt. Preedy.*) Do you not think that the inaccuracy of the firing of the two guns was owing to the ship knocking about?—Very likely indeed; but under those circumstances the 68-pounder smooth bore gun has the advantage, because the aim is not so easily put out on account of the knocking about of the ship. If you can once get the range with the Armstrong gun, it is as accurate as it can be; but the difficulty is in getting the range, and the very least thing puts it out.

2026. It is guess work almost, is it not?—That is true, certainly.

2027. (*Col. Ormsby.*) From your experience of the new system of Armstrong guns, if you were fitting out a ship to-morrow, and were allowed to take what guns you liked for broadside guns, pivot guns, and boat guns, what guns would you take; would you take any Armstrong guns at all?—Honestly, I would not. I may mention what I would take, if I could have them. I would have the 95 cwt. smooth bore gun, which I consider the very best gun I have ever seen, and the next gun to that for accuracy up to about 1,800 yards range is a gun which I particularly objected to, until I found out what it was, and that is the 60 cwt. 8-inch gun. I had 20 of them on board the last ship I commanded. It is the same diameter of bore as the 65 cwt. gun, and just two



inches shorter; 8 feet 10 is the length of the gun. And I would also take the long 32-pounder 56 cwt. gun.

2028. Would not you prefer a rifled gun for a pivot gun?—From what I have seen of the Whitworth gun, and what I have read of it, I should prefer that as a pivot gun, but not as a broadside gun.

2029. (*Col. Simmons.*) Why would you prefer the Whitworth gun for that purpose?—I am merely speaking of what I have read. I never saw the Whitworth gun until four or five days ago; but I am told that the results which have been obtained from that gun, both in penetration and in range, are, if one may say so, wonderful. I think there are no better judges of that than the Americans; and I know that they have taken largely to the Whitworth guns on the Confederate side. The only objection, I believe, to the lighter class Whitworth gun is the increased weight of it. I am told that the 12-pounder Whitworth weighs very much more than the 12-pounder Armstrong, or breech-loading gun.

2030. Are you aware that it only weighs 1 cwt. less?—I was not aware that the difference was so small.

2031. For broadside guns you prefer the smooth bore to a rifle gun?—I do.

2032. Can you tell us for what reason?—The greater rapidity of loading.

2033. Supposing you could get a rifled muzzle loader, would that meet your objection?—I always remember what happened to the Lancaster 68-pounder before Sebastopol, the shot sticking; and I also remember that the two rifled guns on board the "Lynx" burst the first day at Kinburn.

2034. (*Col. Simmons.*) Those were cast-iron guns, were they not?—Yes; they were cast-iron guns.

2035. (*Col. Ormsby.*) The Whitworth guns are muzzle-loaders, are they not?—Yes.

2036. (*Major Young.*) The guns which you have just alluded to were bored up guns, were they not?—Some of them were; but those that burst on board the "Lynx" were not; they were 95 cwt. rifled on Mr. Lancaster's plan; there were some 65 cwt. guns also rifled by him.

2037. (*Col. Taylor.*) Do you never carry in the boats for landing the guns, a couple of side slides?—No.

2038. I think you stated that you cannot shift them from the boat to the shore, and land through the surf; the surf will not allow you to do it?—No. There are dozens of ways of landing a gun out of a boat, if you are not afraid of knocking it about. For instance, with the 12-pounder howitzer in any surf or weather you can land it.

2039. (*Capt. Preedy.*) In working the Armstrong guns on service, have you ever found anything go wrong with them at all?—Nothing, except what I have mentioned; but I think we could hardly form an opinion about that, as far as the Armstrong guns

in New Zealand were concerned, because where we were was within six miles of the sea, and the guns were just taken into position, and there left the whole time they were engaged; they were not shifted 50 yards the whole time.

2040. I mean with regard to the actual loading of the gun, loading and firing without delay?—There was no rapid firing at all. If they fired three rounds at a time, quick firing, that was as much as they did. It was at the time when the firing was very heavy on the head of the sap that they fired three rounds, quick firing. I was talking to poor McNaghten, of the Artillery, about half an hour before he was killed, on the last day that we had of firing there, and I know that his opinion was exactly what I have expressed, and it was a valuable one, as no one serving in that campaign had more experience of rough service like that in New Zealand than he had.

2041. (*Mr. Penn.*) Have you any idea how many rounds might have been fired from those guns generally?—It was no considerable amount at all, but the artillery Report will furnish all that information.

2042. (*Col. Taylor.*) The vent pieces were of the original pattern, flat backed without any projection, were they not?—Just so. With the exception of the guns which were sent to China, those guns which we had in New Zealand were some of the first that had been made.

2043. (*Commander Singer.*) Besides the objection of the greater room that those guns take up in a boat, have you any other reason for preferring the howitzer to the Armstronggun as a boat's gun?—I think the great advantage of the howitzer over the Armstrong gun is that you can fire grape and canister with it. Some people would say that the segment shell answers the purpose, but I do not think it does.

2044. (*Col. Ormsby.*) Do you think that the spread was not enough?—No, it was not enough. If an enemy were coming up close, and you wanted to give them a bag of musket balls or grape, you could do it out of a howitzer, but you could not produce so much effect with a segment shell from an Armstrong gun.

2045. (*Col. Taylor.*) You had no necessity for using the segment shell as case, with the time fuse set at zero, firing close and bursting them at the mouth of the guns?—No.

2046. Judging from what you have seen of that gun, supposing that you could divest the Armstrong gun altogether of that difficulty of the vent piece, have you any other objection to it as a boat gun for naval purposes except its delicacy and the difficulty of landing it through the surf, and its taking up so much room in the boat?—No; I must qualify that in one way. I may, perhaps, be exaggerating it, but I cannot help thinking that there is a want of confidence in the Armstrong gun established among the men.

The witness withdrew.

Captain RICHARD S. HEWLETT, C.B., R.N., examined.

2047. (*Chairman.*) I think you command the "Excellent"?—Yes.

2048. And doubtless you have had a great deal of practice with the Armstrong gun?—Yes, a great deal, and some with the Whitworth gun.

2049. Will you detail to the Committee the result of the practice that you have had with both the Armstrong and the Whitworth gun?—The Armstrong gun I have seen a great deal of practice with, and I have the highest opinion of it in every way, as to its safety, range, and accuracy. I believe it to be a perfectly safe gun with common care, but I think that in the excitement of an action probably the screwing up of the vent piece would be neglected, and that is almost the only thing against it. The minor accident of splitting the vent piece I do not

think of much consequence; it is easily replaced; in fact, if not badly split they can go on using the vent piece for a considerable time, as we are now doing on board the "Excellent." In the early part of the experiments with the Armstrong gun there were flaws discovered in the rifling in three guns which alarmed us, and we returned them for examination; but had we known as much of the gun then as we do now I should not have returned them. In fact we have a 110-pounder on board the ship at this time in constant use, in the bore of which four shells burst and destroyed a good part of the rifling. It was repaired, and we have since that fired between 300 and 400 rounds with it, and are still using it with equal accuracy and range.

2050. (*Col. Simmons.*) How was it repaired?—

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Our range in Portsmouth Harbour is limited. We wanted to fire shell, but we were afraid that if we fired with the full bursting charge some parts of the shell would scatter on the shipping or on the shore, and therefore we reduced the charge to one-half; and it was the friction of the bursting charge that caused the shell to explode in the bore; we ascertained that from experiment afterwards; and it was repaired by simply filing the rifling smooth by a mechanic from the gun wharf, but we are now repairing one by our own artificer.

2051. (*Chairman.*) Is he an instructed man?—No, not an instructed man in this work; he is simply our armourer. The Armstrong gun has a number of advantages over the muzzle-loader, inasmuch as you save a great deal of labour in working it under some circumstances, particularly in fighting a lee gun on board ship—you also gain a great deal of time, and the loaders are in a safer position than when loading at the muzzle. And, also, there is this very great advantage, that you can use very long guns in narrow waisted vessels. With regard to the Whitworth gun, I was five or six years since sent down to Manchester to examine and report upon it; and at that time I stated that I considered the accuracy and range would be very great, but I doubted its safety. Since that time I believe several guns have burst; one has burst on board the "Stork," but that was a cast-iron 68-pounder supplied to Mr. Whitworth, in block, and he bored it out to his own calibre; and another, a homogeneous gun, was split on board. His breech-loading arrangements I considered very defective.

2052. What reasons had you for doubting the stability of his gun?—Because I had seen guns tried before upon the principle of hard metal working against hard metal, and they had burst. I believe that no gun will stand metal working upon metal with a severe twist of rifling for any long period of time. It will stand a number of rounds, but it will go at last. We afterwards tried the Whitworth gun as a muzzle-loader, and we found that after a very few rounds there was a difficulty in getting the shot home.

2053. How long ago was that?—This was about two or three years since.

2054. What was the shape of the projectiles?—They were cylindrical; some were flat-headed, and other were hemispherical.

2055. Was it a tapering projectile?—Some of his projectiles were flat-headed, with the striking point a little larger than the base, for the purpose of using against iron plates.

2056. (*Mr. Penn.*) When you use the term "cylindrical" you do not mean that it is precisely a cylindrical shot; it is a hexagon, is it not?—Yes; it is not cylindrical, I meant hexagonal.

2057. In fact it was a rifled gun?—Yes.

2058. (*Col. Simmons.*) You spoke of a difficulty in loading after a few rounds with the Whitworth; what was it that caused that?—The deposit from the powder getting into the angles of the rifling and hardening there.

2059. Did you use the sponge as in ordinary guns?—Yes, we always used the sponge from the muzzle and also a lubricating wad.

2060. (*Chairman.*) Did this projectile exactly fit the gun that you inspected?—There was a small amount of windage, and the shot went in very easily at first; we had no wads for it, and in running out we found that it started from its seat sometimes a foot or more.

2061. (*Capt. Preedy.*) That would necessitate the use of a wad?—Yes, if that principle were adopted a wad must be used. There is a difficulty in getting the sponge into the angles of the rifling to clean it thoroughly out.

2062. (*Col. Simmons.*) Was this sponge that you used specially constructed for the Whitworth gun?—No, it was simply the ordinary sponge, not constructed purposely for the Whitworth gun.

2063. (*Chairman.*) Had you much practice with the Whitworth gun?—Very little practice; I think that perhaps we did not fire 30 rounds altogether.

2064. (*Mr. Penn.*) That was not lately, I presume?—Not very lately.

2065. (*Chairman.*) Can you state within how many months that occurred?—No, I cannot; it must have been two years since.

2066. (*Mr. Penn.*) Therefore you have had no experience during these last two years?—No.

2067. (*Col. Ormsby.*) Were those brass guns rifled according to Mr. Whitworth's plan, or were they iron guns?—We had brass howitzers sent us in the first place rifled on Mr. Whitworth's principle.

2068. Have you tried Mr. Whitworth's homogeneous metal gun?—Yes, and after 20 or 30 rounds it split.

2069. (*Col. Simmons.*) Was that a large gun?—An 80-pounder.

2070. (*Chairman.*) Whereabouts did it split?—It split at the rear of the chamber, and the injury extended longitudinally two or three feet in that part, and completely through the iron cylinder and the next ring to it.

2071. (*Major Young.*) Were they firing a very large charge at that time?—A 12-lb. charge.

2072. And the weight of the projectile was 80 lbs.?—It was called an 80-pounder, but I think that the shot on this occasion only weighed 70 lb. On the occasion of firing from Mr. Whitworth's cast-iron gun, the difficulty in getting the shot home was so great that we were obliged to put the jolly boat's mast into the muzzle of the gun and make ropes fast at each end, and put a number of men on to try and bump it home.

2073. (*Col. Ormsby.*) That difficulty arose from the gun fouling?—Yes.

2074. (*Col. Simmons.*) Was it a very long shot?—I think about 13 or 14 inches, but I am not quite sure of its length.

2075. Do you remember the calibre of the gun; was it a four-inch bore?—I do not remember exactly, but I think that it was more than that.

2076. (*Capt. Preedy.*) Do you consider the Armstrong projectiles being coated with lead to be an objection to their use on board ship?—Not the slightest; if they become dented it is very easy to cut the projection off. For all rifle guns my opinion is that the shot should be of a compound nature, and that the outer skin should be a soft substance, so that in the event of their hitching in the bore, the shot may strip and escape. I believe the want of that to be a defect in the Whitworth shots, because it was proved after the pieces of the gun that burst had been picked up that the shot had attempted to leave the rifling and got jammed in the bore.

2077. Have you had any experience of the side-loading plan which has been introduced by Sir William Armstrong?—Yes; I saw 100 rounds fired, 50 from a 40-pounder, and 50 from a 70-pounder, on that principle, at Shoeburyness a short time since.

2078. Do you prefer it to the screw?—Yes; nothing could have worked better, we did not observe any escape of gas in the 40-pounder. In the 70-pounder there was some little appearance of it, but it was hardly worth mentioning. That arrangement is also so much safer, inasmuch as you cannot prime till it is wedged up.

2079. You think it would be a great improvement to introduce that on board ship?—No doubt of it. It would do away with the liability of the vent piece not being screwed up.

2080. Would you introduce it with respect to the smaller guns?—Yes, certainly to the smaller guns, and to all others, provided the wedges stand well the explosion of the larger charges.

2081. Are you speaking now of field guns?—Yes, decidedly; but I do not know how far a 110-pounder would stand that system. I do not know whether the escape would be greater, or whether there would be any escape at all; but that has not been tried.



We have not tried any beyond a 70-pounder on that principle.

2082. (*Chairman.*) Do you find that the weight of the vent piece of a 70-pounder makes it difficult for the men to work?—Not in the slightest degree; even in the 110-pounder, two men lift it with the greatest ease.

2083. (*Capt. Preedy.*) What do you consider is the limit as to the weight of a broadside gun in an ordinary ship?—I would not put a broadside gun of more than six tons weight in the port of any ship; that is quite as much as you can work, and then it should be on a slide carriage, and should be fitted with mechanical appliances.

2084. What do you consider to be the limit for a pivot gun, supposing that it could be perfectly controlled by simple machinery, instead of being used with the traversing apparatus?—We had guns in the service of 113 cwt., and they were dismissed because they were too heavy to work, but I think that I would not, even with mechanical appliances, have a pivot gun, that works from side to side, and probably the ship, on the incline of more than five tons. That should be the extreme weight of a pivot gun in my opinion.

2085. I am supposing that you could control it perfectly with some simple machinery that may be hereafter introduced?—If you could control it completely by some simple machinery, and also by some arrangement raise the shot to put into the gun, and if the deck and sides were very strongly constructed, I can then see no limit to the weight of the pivot gun.

2086. (*Commander Singer.*) If there were a turntable amidships, and there were no occasion to bring it to the side, there would be no limit at all?—No; I believe there is no limit to the cupola gun.

2087. The cupola appears to have solved the problem of a heavy gun?—Yes; and it is the only way in my opinion in which we shall be able to carry very heavy guns on board ship.

2088. (*Col. Taylor.*) Do not you think that mechanical arrangements might be adopted by which on the turntable the whole could be lowered so as to house the gun in bad weather?—Yes; we have had fifty suggestions of that kind, but they have all been considered not impracticable, but not necessary, because the cupola is protected by thick iron, and is impenetrable.

2089. What is your opinion of the value of accuracy in this sense. Supposing that you have one gun which will put 75 per cent. of its shot into any reasonably small object, and you have another, which will put 50 per cent. in; do you not consider that the moral effect of the more accurate gun is very much greater than the comparative accuracy of the two would imply?—I suppose that the injury that you would do to the enemy would be in proportion to the number of projectiles that strike; but in a moral point of view, I think that if a crew found that three out of every four shot struck them, they would lose heart.

2090. Do not you consider that accuracy is a quality to be purchased at the sacrifice of some other consideration?—It appears to me that everything depends upon accuracy in enabling you to strike your enemy.

2091. Do you not consider that the advantage of having a gun, which is known to be exceedingly accurate, is so great as to justify your putting up with some little inconveniences in other respects?—No doubt of it; but I do not think that the accuracy of the gun is of so much importance in a sea-going vessel as on the shore.

2092. (*Capt. Preedy.*) Supposing there could be obtained a muzzle-loading gun as effective in every way as the breech-loader, which would you prefer for a ship?—The breech-loader decidedly, excepting for special purposes. You must have a special gun for penetrating or smashing plates; and that I am afraid breech-loaders would not answer for; they would not be strong enough to withstand the effect of the charges that would be necessary.

2093. (*Col. Simmons.*) In an early part of your evidence you stated that when you visited Manchester you formed an opinion as to the Whitworth gun being likely to fail in consequence of the shot being a hard metal working against a hard metal; had you any experience previous to that which impressed you against a hard metal shot?—Yes. I was present when Captain Cavalli's guns were tried at Shoeburyness a great number of years ago; and I saw myself a breech blown out after 20 or 30 rounds.

2094. Was it a cast-iron gun?—Yes.

2095. Then that breech blowing out might have happened with a cast-iron gun even with a projectile coated with a soft metal; it would not be due to the action of the shot against the hard metal of the bore?—No doubt that might be so; but as well as I recollect, I think that several accidents of the same kind occurred with that description of gun; and also, since that, I have heard that Captain Cavalli's guns were given up in Italy on account of their being unsafe.

2096. Did they make them of wrought iron in Italy?—I don't know, but I should think so.

2097. (*Mr. Penn.*) Have you found any serious abrasions in any of the Whitworth guns that you have tried which you could see were cut at all?—No.

2098. (*Major Young.*) Do you not think that the manufacture of the guns could be so perfect, and the manufacture of the shot and the fitting so accurate, that the probability of jamming would be very small?—No, not all; I think you would rather increase the difficulty; it is windage that is required.

2099. With regard to the Lancaster gun; for instance, and the first that was made by Mr. Whitworth, my impression was that, because they had this windage too large, the shot got out of the rifling and jammed, whereas if they were a nice fit they would not do so. Do you agree with that?—I do not think that. I think that the deposit would still have been in the angle of the rifling, and it would probably not have gone on so long as it did without jamming.

2100. You attribute the jamming to a deposit of powder?—Yes, I attribute it to a deposit of powder hardening in the angle of the rifling.

2101. (*Col. Simmons.*) That would point, would it not, to the necessity of a better fitting sponge?—Yes; but we could not use a sponge, or at least we found the sponge would not enter and clean the rifling.

2102. We were shown a sponge the other day at Woolwich which was made with a revolving head of somewhat the same shape as the bore of the gun; have you seen that?—Yes, we have some ourselves in that shape, but they do not answer; they do not effectually clean the rifling.

2103. (*Capt. Preedy.*) If the sponge did fit exactly, would that remove the deposit?—If fitted very tightly it does in some degree remove it, but does not perfectly do so; the deposit becomes immediately hard, and difficult to remove.

2104. If the Whitworth gun were constructed as a breech-loader, would that difficulty be got over?—Yes, we find no difficulty in loading a breech-loader.

2105. The angles of the rifling would not be filled up, would they?—They would be filled up in front, but the projectile would be forced through by the charge behind it.

2106. (*Major Young.*) That would strain your gun too, would it not?—Yes, it would, no doubt.

2107. (*Mr. Penn.*) Suppose you had a Whitworth breech-loader and a Whitworth muzzle-loader, what difference would that make with regard to cleaning the gun; I apprehend that the shot in both cases would be the same?—Yes, just the same.

2108. Then the effect of the boring would be the same?—Just so.

2109. I do not exactly understand why, in the one case, there would be more or less difficulty than in the other?—Because in a breech-loader the shot is only a few inches in, and when you get it into its seat the charge would force the projectile through, and clear away the hard deposit that is in the rifling.

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In the other case you are forcing it down by hand, and you have not strength to push it in in loading.

2110. (*Capt. Preedy.*) What is your opinion of the Armstrong gun as a boat-gun?—I think it a very good gun indeed for boat service.

2111. (*Major Young.*) To what calibre do you allude to?—To the 12-pounder particularly, which is a very nice gun.

2112. (*Capt. Preedy.*) Does it occupy more space in working in the boat than the old gun did, so as to block the oars?—No; on the contrary it is less in the way, and the men are not so exposed in loading.

2113. (*Commander Singer.*) Did you ever have much difficulty in landing it?—None in the world. You may treat your Armstrong guns just as roughly as any guns in the service. The sights are the only things that are more exposed than in the other guns, and you can take them out and fill the holes up with grease.

2114. (*Col. Simmons.*) You would not hesitate to throw them overboard in a surf and drag them through with a hawser?—I would not hesitate to do so. The handle of the breech-screw would be in the way in dragging it up, but I would take out the breech-screw whilst this was going on.

2115. (*Capt. Preedy.*) You could secure a hawser to a gun of that description better than to the old gun, could you not?—Yes.

2116. (*Commander Singer.*) What is your opinion of the 20-pounder as a boat-gun?—The 20-pounder has been reduced in weight to adapt it to boats, and as it has the same charge and projectile as the land service gun, its recoil is violent; still I prefer it to the 24-pounder howitzer.

2117. Do the present lanyards stand the recoil of that gun without being injured?—Yes; but the fittings have been strengthened, and the size of the bolts increased, but with the old 24-pounder howitzer the recoil was just as violent as with this one, and it required strengthening for them, as well as for the 20-pounder.

2118. (*Col. Simmons.*) The Committee have it in evidence that four oars out of fourteen were sacrificed by placing the 12-pounder field gun in a boat as compared with the 12-pounder howitzer. Do you concur in that opinion?—I disagree entirely with this evidence.

2119. (*Capt. Preedy.*) It was not the same gun exactly as the present one, it was the long gun which was first introduced?—That of course would alter the case. The 12-pounder has been shortened for a boat gun.

2120. (*Commander Singer.*) With respect to the Armstrong guns as field guns, what is your opinion?—I think that they possess a very great advantage as field guns.

2121. Do you think that in a battery a combination of 20-pounders with 12-pounders is very advantageous?—No doubt of it. These breech-loading guns possess a great advantage in the field in protecting the men who are loading; instead of the men standing out in front to sponge and load, and being marks for the enemy's riflemen, they are very much protected behind the guns.

2122. (*Capt. Preedy.*) What is your opinion of the time and the pillar fuses which are supplied for naval purposes?—The pillar fuses have answered very well, but we have not had much experience with them. The time fuses we find deteriorate, and their action is irregular.

2123. (*Col. Taylor.*) Were those time fuses which you speak of on the old pattern?—Yes.

2124. Have you not found the deterioration of them gradual and progressive?—We observed it about 18 months after they were first sent to us. We endeavoured to find out the dates of their manufacture, but that we have not been able to ascertain; we observed that the deterioration came on very rapidly, but it was progressive.

2125. (*Col. Simmons.*) Where was it that they suffered deterioration, in what part of the fuse?—I suppose it was the composition.

2126. Do you mean the detonating composition?—No; the burning composition.

2127. (*Col. Taylor.*) Did it become uncertain?—Very uncertain; and I recently had reports from many ships abroad that they find the same defect. In their reports upon the time fuses in the Armstrong shells, they state that some have burst prematurely, and others have not burst at all.

2128. Have you had any of the last pattern?—No.

2129. (*Col. Simmons.*) Have you found any of them deteriorate in their detonating composition?—That I cannot say; some of the shells do not explode at all, and this might be from the detonating composition failing to act, but I think not.

2130. (*Capt. Preedy.*) How do you find the men, generally speaking, take to the Armstrong gun, is there any want of confidence in working them?—No, not on board the Excellent.

2131. You never had any experience of your men wanting confidence in those guns?—No; they appear to me to have the most perfect confidence in them. The Armstrong guns, I think, only require to be understood to give one the most perfect confidence in them. The gun is not well known in the fleet, and therefore the men have a fear of it. In two or three cases they have neglected to screw the vent piece up, and there has been an escape of gas which has rather frightened them.

2132. How long does it take to train the sailors to the use of the Armstrong gun?—I think you can get through all the working part of it in a week.

2133. (*Major Young.*) That is to say, provided a man is trained beforehand with the old smooth bore?—Yes, they go through the smooth bore exercise first, and then come to the Armstrong gun afterwards.

2134. (*Col. Simmons.*) Have you had many vent pieces blown out in the course of your practice with the Armstrong gun?—We had, I think, two blown out, one from a 20-pounder and another from a 40-pounder, and an escape of gas from a 40-pounder as well.

2135. Was the effect very violent?—Yes, the concussion was very violent; it shook down the bulkheads of some of the cabins.

2136. Have you had many of them split and break up?—Very few. I think that in all our firing we have had only about eight which did that.

2137. Were any fragments of them blown out so as to cause any liability to injury to the crew?—Never. We have one injured now, a 110-pounder, and they are going on firing with it; it is only cracked.

2138. (*Col. Ormsby.*) Have you any of the new pattern vent pieces?—Yes.

2139. Have any of them split or blown out?—Not one.

2140. (*Col. Taylor.*) Have you ever found any with the projection behind blow out?—No, never.

2141. (*Capt. Preedy.*) Do you think that the projection quite meets the objection to the vent piece?—Yes, I think quite so; there is no fear of their being blown out now, although the escape of gas may be very great if it is not screwed up.

2142. (*Chairman.*) Has the vent piece which has been split and which you are now using a projection?—Yes; the crack is just under the projection; it is not very much; we are going on firing with it to see whether it will extend or not.

2143. (*Col. Simmons.*) Do you know whether that vent piece is made of steel or iron?—Of wrought iron.

2144. (*Commander Singer.*) In the new pattern 40-pounders, have you had any of the vent pieces go?—No.

2145. (*Col. Simmons.*) Have you to renew the copper rings on the vent pieces very often?—No, I think not very often; we resurface them after every 200 or 300 rounds more or less, but some guns go on firing 600 or 700 rounds without requiring that.



2146. Do you find any difficulty in resurfacing or renewing them with your own men?—None whatever; we instruct our men how to do it; we have special tools to do it with.

2147. (*Chairman.*) What is the greatest number of rounds that you have fired with any one Armstrong gun?—I think we fired 1,000 rounds from one 40-pounder, and with the same breeching.

2148. (*Col. Ormsby.*) In what state is that gun now?—In a very good state; perfectly serviceable.

2149. (*Capt. Preedy.*) If you commanded a squadron, would you desire that all the ships composing that squadron should be armed with rifled guns?—Certainly not. I am very strongly against that. I believe that the rifled gun is best for special service, for long ranges, and for bombarding; but the principal armament of our ships should still be the smooth bore; it possesses many advantages which the rifled gun does not, more especially with regard to ricochet. In our target practice we frequently see a shot fall short and ricochet into the target; a very large per-centage of shot do that, but with the rifled guns they deflect, and not only that, but they rise at a very high angle, and they pitch again some hundreds of yards off.

2150. (*Col. Ormsby.*) You consider them very eccentric in their ricochet?—Yes.

2151. (*Chairman.*) For broadside guns would you prefer the smooth bore?—Yes; I should prefer smooth bore guns, but I would also have a proportion of rifled guns on board for special purposes. If you could get a really safe and secure gun, and there was no fear of any neglect causing serious accidents, I should then possibly increase the number of rifled guns on board, but the majority should, in my opinion, still be smooth bores. For parapet firing you cannot use the rifled guns. Perhaps you might get over that by having the fuse more sensitive; but the only way you can effectually shell a battery at short distances is by laying your guns at a fixed elevation, and with a small charge throw the shells over the parapet.

2152. (*Col. Taylor.*) What is the smallest charge that you have found would cock the concussion fuse, if I may use the term?—I do not know; we tried the small charges that we used in parapet firing; but I do not know what charge will make the fuse act. I think we have tried the time fuses with 23 ounces and they have not acted.

2153. (*Col. Ormsby.*) You would propose the rifled guns on board ship with a mixture of smooth bore guns, to be breech-loaders and not muzzle-loaders?—I should prefer the breech-loaders. Both description of guns have advantages, but I think the breech-loaders possess more advantages than the others.

2154. Which can you fire most rapidly with, the breech or the muzzle loader?—The breech-loader, decidedly, and under some circumstances infinitely more so. You have no sponging, and you have not to run the gun in, which you must always do with a smooth-bore gun. With a lee-gun, where the gun would not perhaps come half way in, the labour saved is very great in a breech-loader.

2155. Is there much difference in the rapidity of firing?—On an even keel not very much.

2156. The breech-loading system you consider has the advantage?—Yes; I think breech-loading has the advantage.

2157. (*Col. Taylor.*) Do not you consider that, when the thing is properly explained and understood, there is a great element of confidence in the fact that those coiled guns always show deterioration before they become really dangerous?—No doubt that gives very great confidence.

2158. Then if you could divest the vent piece of all destructibility, if you could secure its being indestructible, you do not see any fault to find with the breech-loading 110-pounder gun for general purposes?—Not the slightest. I have a very high opinion of all the Armstrong guns. I feel the most

perfect confidence in their safety. I could stand behind them with a feeling of perfect safety.

2159. (*Col. Simmons.*) Have you had any of your breech screws strip?—Yes; we have had some little difficulty with them, but nothing to speak of.

2160. Nothing that would have stopped your firing?—On one or two occasions it has, but spare screws are now supplied.

2161. (*Major Young.*) You do not find any fouling in the screw, do you?—They do sometimes foul a little, but not to prevent the screwing up of the breech piece. It makes them a little stiff sometimes.

2162. (*Chairman.*) Are the crews for the "Excellent" selected men?—Yes, they are men of very good character, and intelligent men, and able seamen who are allowed to join.

2163. (*Col. Ormsby.*) Have you found the Armstrong ammunition liable to separate on board ship, from damp or other causes?—Not at all.

2164. Not more so than the old ammunition?—Not at all.

2165. Have you fired much under water?—Yes, we have had a great deal of practice lately under water with the Armstrong 110-pounder, and also with the 32-pounder smooth bore.

2166. What gun do you prefer for firing under water?—The Armstrong gun with the Armstrong elongated projectile, because it has more power of overcoming the resistance of the water. I think that the 110-pounder Armstrong gun penetrated the wood at about 20 or 25 feet, and a 3-inch iron plate at 20 feet distance.

2167. (*Major Young.*) What was the thickness of the wood?—About 20 or 22 inches.

2168. (*Col. Ormsby.*) Have you fired the Whitworth gun under water at all?—We fired the Whitworth brass howitzer from above the water, and it penetrated the water, but the gun was not under the water.

2169. Was the effect good?—Very good indeed.

2170. Which was the best, that or the Armstrong gun?—The Armstrong projectiles did not penetrate the water, being round headed; had they been flat headed they would probably have acted as well as Mr. Whitworth's.

2171. Had the gun been any time under water when it was fired?—Many hours. It had been there for two or three weeks, but it was loaded a few hours before the tide came in, and then they waited till the tide got six feet high before firing it.

2172. (*Capt. Preedy.*) Did that injure the gun in any way?—Not the slightest. We took it up and cleaned it, and it has gone on firing since. I think an Armstrong gun will last for ever.

2173. Was it the same charge as you used above water?—Yes, the same charge; it was the highest charge, 14 lbs.

2174. Did you try any shell?—Yes, we tried shells, and the effect was very great indeed; it made a hole in the bottom of the "Griper" which I could have crept into.

2175. (*Major Young.*) What fuse did you use?—We used the pillar percussion fuse.

2176. (*Col. Taylor.*) At what distance was it?—At about 20 feet.

2177. (*Capt. Preedy.*) Do you think that could be carried out in actual warfare?—I am sure of it. We are going to fit an experimental port in an old vessel; there is no difficulty about it, and we have everything arranged.

2178. (*Col. Simmons.*) For that purpose the breech-loader would be particularly valuable, would it not?—Yes; it would be particularly valuable.

2179. (*Col. Taylor.*) That would be done by having the gun sunk in a special chamber for it, and made completely watertight, the front of which would be blown out?—No. Our plan has been to tie an old drum-head tight round the muzzle, and lute it, and that has kept the water out for hours. You may let the water in if you like, but in that case you do not get the same effect, because the projectile

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has no time to get the initial velocity before coming into contact with the water.

2180. (*Major Young.*) One would fancy almost that the fuse would act in coming against that large column of water?—It did, on one occasion; at least the shell burst in the gun, and we supposed that it was from that cause, but we fired with a 14 lb. charge, which is 2 lbs. greater than is generally used for the 110-pounder shell. On that occasion it did burst in the bore, and we considered that that was very likely to have been caused by the shock on the shell coming into contact with the water.

2181. Does its being fired under water strain your gun much?—Not at all that we could perceive.

2182. (*Commander Singer.*) With respect to ease of working, do you consider that the Armstrong gun is as easily worked as the corresponding smooth bore?—It is more easy to work.

2183. In the case of the 110-pounder, do you think that there would be much more difficulty in working it with the ship knocking about, than with an even keel?—No. The ship knocking about in moderation would rather assist the working the gun than otherwise.

2184. (*Col. Simmons.*) How is it with regard to the recoil?—The gun comes in perhaps rather sharper than the smooth bores, but you must recollect that the weight of the gun is very much less, and consequently the strain upon the breeching and the bolts is less.

2185. And the charge is less also?—Yes.

2186. Do you find that it carries away your breechings and bolts at all?—No; I mentioned that from one gun we fired 1,000 rounds with the same breeching.

2187. (*Col. Ormsby.*) What gun would you take for firing against a ship plated with iron?—Then you must have a muzzle-loading gun, because I do not believe any breech-loading gun can be made strong enough to stand the effects of the very large charges which are requisite to obtain the necessary velocity for penetrating plates.

2188. Have you had any practice with the Whitworth gun against iron plates?—I saw some practice with it, and it appears to have done more than any other rifled gun, and if those objections could be got over with respect to the loading and the safety, that would be the gun that I would choose for this especial purpose.

2189. If you required a gun for that special purpose, would you take the Whitworth gun if it were left to yourself?—Certainly not, until its safety and the power of loading were clearly established.

2190. (*Col. Simmons.*) In fact you have no confidence in Mr. Whitworth's homogeneous gun?—I have great confidence in homogeneous guns, but I have no confidence in the metal working against metal and with the severe rifle twist which it has.

2191. (*Col. Ormsby.*) Do you think that the Armstrong segment shell is an effective one at short ranges?—Not at too short a range.

2192. What is the shortest range at which you would say it is effective?—I do not think we get them to burst under about 150 yards, speaking from memory.

2193. (*Col. Simmons.*) So that at less than 150 yards you have no shell in the service with the Armstrong gun which takes the place of grape and canister?—No; but that is a defect which can easily be got over by bags of musket balls.

2194. (*Col. Ormsby.*) Have you ever tried to fire musket balls with an Armstrong gun?—No, never.

2195. (*Col. Simmons.*) Do you prefer a time fuse that is ignited upon the percussion principle to one that is ignited by the flame from the powder?—No; I should certainly prefer the one that is ignited by the charge if it were possible.

2196. (*Commander Singer.*) It being a simpler fuse?—Yes.

2197. (*Major Young.*) And getting rid of the detonating compositions?—Yes.

2198. (*Col. Ormsby.*) Have you had any practice with the Armstrong shunt gun?—Never; I have seen it at Shoeburyness.

2199. Have you found the Armstrong projectiles injure much on board ship?—Not at all. We have had now some projectiles put for trial on a battery near the "Excellent," and we cut some of them open, to allow the rain and the spray from the sea to go in, and really there is not the slightest appearance of rust upon them; they have not deteriorated in the slightest degree; they have been there now nearly two years, and are still there, and we opened one the other day to see if it had been affected, but found no appearance of any chemical action.

2200. Do you find the fuses deteriorate?—Yes.

2201. Have you any of the new fuses?—No; they are not issued yet.

2202. (*Commander Singer.*) Do you know how the lead is secured on those projectiles that you have mentioned?—Yes; they are undercut.

2203. (*Chairman.*) Have you tried to fire a gun with shot that has been exposed in the manner you have described?—No; we have not fired any; but still we could fire them, without doubt.

2204. (*Col. Ormsby.*) Have you found the lead strip much off the shot?—Not latterly; not for a long time now. At first, great numbers of them stripped.

2205. Have you any shot to which the zinc process has been applied?—I do not know whether we have any with the zinc process, but evidently something has been done to them; what the alteration has been I do not know. Lubricating wads have been introduced since that time, and that may have had some effect in preventing the shot stripping.

2206. (*Chairman.*) How do you stow your lubricating wads on board ship?—They are kept in the store rooms and brought up to the gun which is going into action or practice, and they screw them on.

2207. (*Captain Preedy.*) Is there any delay in screwing on the wad?—Not the slightest, it is put in and turned round in a moment.

2208. (*Col. Ormsby.*) Have you fired any Armstrong shells filled with molten iron?—No.

2209. (*Chairman.*) Are any of your Armstrong guns on the main deck field guns?—Yes.

2210. Have you found any bad results from the smoke?—Not the slightest.

2211. (*Commander Singer.*) Have you frequently fired the 100 pounder between decks?—Yes, frequently; if the wind is blowing on that side of the ship towards the shore there is a little smoke comes in, but not more than would be the case with a smooth bore, and nothing to make it disagreeable.

2212. (*Col. Ormsby.*) Do you think, from the construction of the Armstrong guns, that they are capable of bearing continued and rapid firing?—Yes, I feel sure of it.

2213. Quite as much so as the old smooth bores?—Quite. We fired 100 rounds as fast as we possibly could from one gun.

2214. Do you remember how long you were firing the 100 rounds?—I think we were about 80 minutes firing at the target, and making good practice.

2215. (*Col. Simmons.*) Do you find at all in the course of your practice with those Armstrong guns, that the chamber for the powder is enlarged by that rapid firing?—We have not found it so; if it was so, it was inappreciable; we did not discover it.

2216. (*Commander Singer.*) Do you find that the chamber gets permanently enlarged or worn?—Not at all.

2217. (*Col. Taylor.*) You have some 110-pounders with the wrought-iron bolts, have you not?—I have seen some tried.

2218. (*Col. Ormsby.*) Do you like the Armstrong fuses better than the Boxer fuses, if the Armstrong gun could be constructed so as to fire the Boxer fuses?—Yes; I like them better because you can set the fuse without removing it from the shell; but nothing can be more certain than the Boxer fuse.



2219. If you were fitting out a ship for foreign service, and were going out to a hot climate, from what you have seen of the Armstrong fuses, would you prefer his time fuse to the Boxer's time fuse, if you could use both?—No, not the present ones, because they have failed, and are uncertain in their action.

2220. Do you think that in the fuses which are supposed, to be hermetically sealed, there is something inside them which generates damp, and that they would deteriorate in hot climates?—I do not think so.

2221. Have you been much in hot climates?—Yes.

2222. (*Col. Simmons.*) Do not you think it possible that the element of destructibility may be inherent in the materials themselves, and is not due to the climate?—We have often thought that many of

the premature bursts are caused by the pewter fuses having been blown out, they not having a sufficient hold on the worm, because we have frequently picked up shells with the fuses out, but I believe, the new ones are made of brass.

2223. (*Col. Ormsby.*) Do you think that immersing a fuse into the water for a certain time, say two or three years, would be as great a trial to the fuse as its being the same time in a hot climate?—Its being in water for that time would be a greater trial than being in a hot climate.

2224. It is not exposed to air in the water?—No; but it is exposed to damp. We do not find our fuses deteriorate in hot climates. Ships which have been four years in China and the coast of Africa, and so on, are obliged to send to us when they come home a certain number of time fuses to try; we time them, and find that they generally burn very correctly.

The witness withdrew.

Captain RICHARD ASHMORE POWELL, R.N., examined.

2225. (*Chairman.*) You commanded a vessel with Armstrong guns on board, did you not?—There were four of them in the ship on the main deck, and two on the upper deck.

2226. What were they?—110-pounders.

2227. Had you much practice with those guns, and could you inform the Committee of the result of your practice and observation with them?—We only exercised with them twice whilst I was in the ship.

2228. What was the result of that practice?—We were satisfied with them with the exception of the vent pieces breaking twice, and I was not satisfied with the facility for training.

2229. (*Col. Taylor.*) That had reference rather to the carriage, had it not?—Yes, certainly owing to the shortness of the carriage; but the carriage is short, I take it, owing to the nature of the gun.

2230. (*Chairman.*) How long ago is it since this practice took place?—Seven months ago.

2231. (*Col. Simmons.*) Did you fire many rounds in that practice?—We fired from 16 to 20 rounds one time, and the other time four or five rounds.

2232. From all the guns?—Yes, from all the guns.

2233. And two vent pieces gave way?—Yes.

2234. How did they give?—They cracked in the centre.

2235. Did any of the fragments fly out?—No.

2236. (*Col. Taylor.*) They were not blown out?—No; nothing but smoke escaped.

2237. (*Col. Simmons.*) Was there enough of smoke to inconvenience you between decks?—No, certainly not.

2238. (*Commander Singer.*) Were those vent pieces of steel or of wrought iron?—They were of wrought iron.

2239. (*Col. Simmons.*) There is a new pattern vent piece with a projection behind, so as to fit into the screw. Had the vent pieces which you used the projection behind?—The ones that were injured had not that projection.

2240. The practice which you had was on board the "Defence," was it not?—Yes.

2241. Was that in a heavy sea at all?—No, certainly not.

2242. (*Capt. Preedy.*) Have you found any difficulty in working the gun?—The training was the only difficult point; otherwise there is no difficulty. The men knew their work and they did it.

2243. It took longer to train with the Armstrong gun than with the old gun?—Yes; I think that all the working was longer than with the muzzle-loader.

2244. (*Commander Singer.*) What description of carriage had they?—The common Armstrong carriage, with a train bar.

2245. The training was necessarily slow and difficult?—Yes; it was on a pivot, and had a train bar.

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2246. (*Capt. Preedy.*) Do you consider it a good gun for a cupola?—Yes, I think there is a great advantage in having a breech-loader for a cupola.

2247. For what reasons?—The cupola is so confined inside that I think you would have a difficulty in loading a muzzle-loader.

2248. The men would not be so much exposed in the one case as in the other?—No.

2249. (*Col. Simmons.*) What is the internal diameter of the cupola itself?—It was 18 feet or 21 feet.

2250. It would be very difficult to load a muzzle-loader in that restricted space, would it not?—Yes. This gun recoiled up an inclined plane, and ran back into its place.

2251. (*Col. Taylor.*) Was that from its own gravity?—It ran up an inclined plane with the recoil, and its own gravity took it back. It would have been an exceedingly awkward position for a muzzle-loader, because the muzzle was down and the breech was right up when it came to its extreme recoil. On the principle that I saw, the gun could not well have been made a muzzle-loader. In the "Royal Sovereign" they are to be turrets, which has quite altered the question.

2252. (*Capt. Preedy.*) Have you any objection to bring forward against the Armstrong gun, so far as your experience goes?—My impression was, when trying the cupola and practising against it, both with the guns in it and the guns against it, that I myself lost confidence in it, and I think that the men lost confidence in it also, from the vent pieces very often going; they went continually.

2253. Was a heavier charge than ordinary used in those experiments?—No, we happened to be singularly unfortunate. The gun was a 40-pounder, and we never could get seven rounds out of it without the vent piece going, when it was an object to get 15 rounds if we could. The gun was very inconvenient; on one occasion the escape of gas was so great as to singe the officer who was behind it.

2254. Supposing that difficulty to be entirely got over, have you any other objections, to the breech-loading Armstrong gun, from your experience at sea?—I think it is much more liable to be injured from shot or splinters than the common gun. From what I have seen I should say that in an action a very great many would be disabled. I have seen shot strike common guns a great many times, and they have been none the worse for it; whereas there are so many vulnerable points about the Armstrong gun, that that would disable it altogether.

2255. (*Col. Ormsby.*) Would you name those vulnerable parts?—I conceive that if the screw was struck it would disable a gun, and if the lever handles were broken off.

2256. You can easily put a fresh screw in, can you not?—But it would be very likely to be jammed

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in if it was struck. An odd circumstance occurred in the "Defence" which I could not account for. In the levers there are two handles, and the recoil knocked off one of them; everybody said that it certainly never struck anything, but the lever handle dropped out and broke.

2257. (*Capt. Preedy.*) Have you seen the side-loading principle adapted to the Armstrong gun?—I have seen the gun, but I have never seen it tried.

2258. Have you had any experience with the 12-pounder Armstrong gun as a boat-gun?—Yes; I have seen it fired a few times.

2259. Do you see any objection to it as a boat-gun?—It was a little violent in its recoil, I thought.

2260. (*Commander Singer.*) More so than that of the smooth-bore which it was supposed to replace?—Yes, I thought so.

2261. (*Col. Simmons.*) Do you apprehend that the Armstrong gun, if used as a boat-gun, would be more liable to injury in boating expeditions, disembarking, and that sort of thing, or on a beach with a surf, than an ordinary gun?—It would be a little more inconvenient, because you would have to take out the screw, and you would have to be very careful that no sand got into the gun. You must be very particular that there is nothing left in the bore. It would take more time, certainly.

2262. (*Commander Singer.*) Still, if you required to land the gun you would not hesitate about throwing it overboard?—I think not, but I should be inclined to take the levers off, as they might get broken.

2263. You would take the levers off and unship the sights?—Yes, I should take the levers off. I would leave the screw in, and I should have no hesitation in throwing the gun overboard.

2264. (*Capt. Preedy.*) Had you the 110-pounder as a broadside gun in the "Defence"?—Yes, we had four of them as broadside guns on the main deck.

2265. What do you consider the limit as to weight of a gun to be worked by the crew as a broadside gun?—The question implies of course with every appliance to bear the weight and to work it.

2266. The gun must be worked of course by the crew in a slide carriage?—I see no objection to 200 cwt., if I may use any appliance.

2267. You cannot expect to work that gun rapidly as a broadside gun?—No, not rapidly; but I see no impossibility in that gun being in the ship, and being worked. I do not speak of the Armstrong gun, because the lever in the Armstrong gun brings in another element; in putting in the vent piece with an Armstrong gun the height between decks becomes an important element.

2268. (*Col. Taylor.*) You could not go beyond the 110-pounder with the vent piece because you could not handle it?—I think not.

2269. (*Commander Singer.*) With respect to the accuracy of the gun, you had the means of observing that, and you consider it everything that could be wished for?—Very satisfactory indeed.

2270. (*Major Young.*) Did you fire at long ranges?—We never fired beyond 2,000 yards, and that I suppose you do not call a long range, although we do.

2271. After firing one round at that range did you find any difficulty in re-loading?—I cannot remember any difficulty arising.

2272. Did you have to depress the gun in order to put in the shot?—As soon as the gun was in, the breech was raised. I think for five or six degrees elevation it was necessary.

2273. That took up a considerable amount of time, I suppose?—I do not think it took up much time; I do not think we suffered from that circumstance.

2274. (*Commander Singer.*) It would not be the same man as raised the breech that placed the shot in?—No; I do not think that that causes much difficulty, it was not far to raise it.

2275. Do you consider the recoil of the 110-pounder intense as compared with that of the smooth-bore of the same calibre?—No, I do not think so.

2276. Is it perfectly controllable with the appliances you have got?—Yes, I think so; quite controllable.

2277. (*Capt. Preedy.*) Had you any pivot gun in the "Defence"?—In the upper deck we had two.

2278. (*Chairman.*) Were they Armstrong guns?—Yes, they were 110-pounder Armstrongs.

2279. Were they the same description of gun as you had on the main deck?—Yes.

2280. (*Col. Ormsby.*) Do you consider that you can fire an Armstrong breech-loader as quickly as a muzzle-loader?—I think not.

2281. Which do you prefer on board ship, a muzzle-loader or a breech-loader, supposing in every other respect the accuracy and range and so forth were equal, and supposing you were fitting out your own ship, and had your choice to take what guns you liked?—I should take the minority of Armstrongs, and the majority of muzzle-loaders.

2282. (*Col. Taylor.*) You bear in mind of course, their relative ricochet, and that the shot from a rifled gun always goes off in the direction of the rifling, whereas the other goes straight?—Yes. At present I would take the majority of smooth-bores and muzzle-loaders, and the minority of Armstrong breech-loaders.

2283. You stated, if I remember rightly, that you do not know anything about the Whitworth guns?—No, I do not.

2284. (*Col. Simmons.*) Have you seen Sir William Armstrong's muzzle-loading shunt gun?—I have seen it, and I know something of the principle, but I have never used it.

2285. (*Col. Ormsby.*) Do you think it is harder work for the men to work a breech-loader than a muzzle-loader?—No, I think not; on the contrary, it is less fatiguing; but I think it is inconsistent with great rapidity of fire; the care that is required of course takes up more time.

2286. Have you ever seen any Armstrong guns subjected to rough usage at all?—No, I have never seen them struck by shot or anything of that kind.

2287. (*Col. Taylor.*) From what you have generally seen of the effect of the shot, should you think that a shot striking the lever of the Armstrong 110-pounder, we will say, would be more likely to carry away a portion of the lever or injure the breech screw?—I think that would depend upon the position of the breech screw, and the extent to which it is screwed up. I think if it struck the gun when the breech screw was screwed up, then it would break the lever.

2288. If they were in action, and three or four threads of the breech screw were run out, do you think that would be likely to alter the conditions?—Yes; I think there would be a violent jar.

2289. (*Commander Singer.*) Do you find any difficulty in handling the vent piece of the 110-pounder?—No; it requires men of a certain height.

2290. But you find no great difficulty with regard to that?—No; in a cupola or a turret you can apply mechanical means to do it, and it is done more rapidly and well.

2291. Did you find that the difficulty in working the vent piece and the levers of the gun generally was much injured by the ship knocking about?—It was a little, just at lifting the vent piece and keeping it steady.

2292. Had you a saddle for it to rest on?—Yes, there was a saddle.

2293. (*Col. Taylor.*) You never saw an instance of a vent piece dropped at drill by the men who were in charge of it at sea?—I believe I have seen one nearly dropped; it slipped.

2294. (*Commander Singer.*) Had you any difficulty or inconvenience arising from the vent piece being jammed by the tin cup, or from being unable to lift it up after a round, or perhaps you had not the tin cup in your gun?—We had the tin cup and the vent piece constantly jammed.



2295. I mean an instance of the vent piece being jammed by means of the tin cup?—The cup used to jam, and there was a loss of time in getting out the vent piece. We had generally to knock it with something inside before the men could lift it.

2296. Have you had any experience of the 20-pounder as a boat gun?—No; it was a small gun that we had—a 12-pounder, not a 20-pounder.

2297. Had you not a 20-pounder at all?—Yes, we had a 20-pounder on board, but it was not used in the boats; we might have used it in the boats, but we did not.

2298. (*Col. Ormsby.*) Do you consider the Armstrong guns to be good shell guns?—Yes, very good.

2299. (*Col. Taylor.*) Have you seen any practice against iron plates or a cupola?—Yes; I have seen some practice against a cupola.

2300. Have you heard of the practice that was made from a gunboat?—Yes, at 180 and 200 yards.

2301. The effect produced upon the cupola was not very great, if I remember rightly?—No, very little, excepting when four shots struck the same plate.

2302. (*Capt. Preedy.*) Was the cupola rendered unserviceable?—Certainly not; the cupola went on as well as ever. The gun inside might possibly have been rendered unserviceable. We changed the gun when we fired at it; we did not keep an Armstrong gun inside.

2303. Was the gun struck that was inside?—Yes, the gun was knocked to pieces, but not by that shot, but other shots that struck it in the muzzle. The cupola turned round as well as ever after we knocked a hole in it.

2304. (*Col. Taylor.*) Did you suffer much from the concussion of the breech-loading gun inside the cupola, or more do you think than you would with a smooth-bore?—When the vent-piece went the men have declared that there was a most marked difference, a peculiar ringing sound.

2305. You had no vent piece blown out?—No, one was stuck in, and we could not get it out without having to send to Woolwich, but none were absolutely blown out.

2306. Do you remember whether those vent pieces were of the last pattern, having the projection behind?—No, they were most of them steel.

2307. (*Col. Ormsby.*) Do you think the Armstrong projectile is a good one for ricochet firing in the water?—No, I should say that there is no dependence to be placed upon it at all, from my experience in the matter.

2308. (*Col. Simmons.*) I suppose you take into consideration, saying that you prefer a certain portion of smooth-bores in a ship, the chance of hitting after striking the water being so much greater with a smooth-bore than with a rifled?—It is an element, most unquestionably, but I thought more of rapid firing at close quarters.

2309. (*Col. Ormsby.*) Do you like the fuses of Sir William Armstrong?—Yes, I find them very successful always.

2310. Do you prefer them to the old Boxer's fuse, or, if the latter could be used with the Armstrong gun, which would you prefer?—I never saw anything the matter with the Armstrong fuse, it always did what was required of it. *Captain R. A. Powell, R.N.*  
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2311. (*Major Young.*) Do you think it was as easy to fix and to arrange as the old Boxer fuse?—Yes, I think we got into the way of it very easily.

2312. (*Col. Taylor.*) Do not you consider it is an advantage, the fixing of the fuse not being made finite, so that you can alter the fuse, that is to say, if you find that you have fired a shot the result of which has not been satisfactory or that the vessel has changed its position, you can alter the fuse without sacrificing your fuse or unfixing it again?—Yes, very much so.

2313. Whereas the ordinary fuse once bored is only available for that distance?—Just so.

2314. Did you have any instance, in the "Trusty" experiments, of shot that you could not use from having been dented by blows?—No.

2315. How was the shot with which you were firing stowed in the cupola?—It was handed up from below each round.

2316. Had you not any shot waiting on deck to be used?—No, it all came up to us through the cupola.

2317. (*Major Young.*) Have you had any experience with the cupolas?—Yes.

2318. With the 40-pounder guns, I presume?—Yes.

2319. Have you found that they worked readily as far as the traversing, &c. was concerned?—Very much so.

2320. Do you think you could work them as readily in a rough sea as you could on an even keel?—Yes, I should think so certainly. I think that the training for quickness and accuracy is unequalled in any other invention that I have seen.

2321. You think there is no probability of the parts becoming disarranged in rough weather?—No, I should think not.

2322. Do you prefer a breech-loader for a cupola to a muzzle-loader?—I think for a cupola a breech-loader is almost indispensable; it is a very great advantage at all events. Of course I distinguish between a cupola and a turret; the cupola principle is almost exploded. I believe the "Royal Sovereign" is to have turrets.

2323. What is the difference between the two?—A turret is a cylinder, and a cupola is the frustrum of a cone.

2324. What was the reason of that change; was it to get more room?—To give more room up high; one loses the double deflection. I think myself that it will make a difference relative to its defensive powers.

2325. It would be disadvantageous to the present arrangements?—Yes, I think it would be disadvantageous. I do not think its defensive power will be quite the same; it will not be equal to the cupola.

2326. There would be two inclines, whereas there is only one incline now, and only one chance of glancing in one direction?—Just so.

The witness withdrew.

Adjourned to Thursday at 11 o'clock.

Thursday, 19th February 1863.

PRESENT :

MAJOR-GENERAL RUMLEY, Inspector-General  
of Infantry.  
COLONEL ORMSBY, R.A.  
COLONEL TAYLOR, R.A., Commandant of the  
School of Gunnery.  
CAPTAIN PREEDY, C.B., R.N.

COLONEL SIMMONS, C.B., R.E.  
COMMANDER SINGER, R.N.  
MAJOR YOUNG, Director of Artillery Studies.  
JOHN PENN, Esq., F.R.S.  
WILLIAM POLE, Esq., F.R.S.

CAPTAIN DYER, R.A., Assistant Inspector of Artillery, Secretary.

MAJOR-GENERAL RANDAL RUMLEY IN THE CHAIR.

JOHN ANDERSON, Esq., examined.

J. Anderson,  
Esq.

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2327. (*Chairman.*) What office do you hold?—My designation is Assistant Superintendent of the Royal Gun Factory at Woolwich, but I may observe that although that is my title, I have really been conducting the works at Woolwich for the last four years entirely on my own resources, so far as regards the management of the department.

2328. (*Mr. Pole.*) You have seen, no doubt, a great deal of almost all practicable modes of making guns?—Yes, I have seen a good deal.

2329. There are four materials of which guns are usually made, cast iron, bronze, wrought iron, and steel; will you allow me first to ask you what is your opinion of cast iron, as a metal adapted for making rifled artillery, what are its defects?—It has a great many very good points about it, but there are some defective points to get over. The great defect is its uncertainty. It is very good in its power of resisting compression, in fact better than many other substances that are more spoken of; but, with regard to its tenacity, it is defective in that respect. Sometimes we get it up to six tons on the square inch, sometimes ten tons, and sometimes even higher.

2330. But, on account of its deficiency of strength, it requires great weight to produce guns of the proper strength, does it not?—Yes.

2331. Is it as well suited for grooves as wrought iron?—Its power of resisting compression is greater than that of wrought iron.

2332. Are the grooves in cast iron strong enough to be useful?—It is not in that direction that cast iron is defective, it is more in its want of tenacity and the shortness of its elasticity.

2333. Do you think that the defects of cast iron may be well got over by any system of hooping with wrought iron?—I am not quite sure that that could not be done; I rather think that it could if the hooping were properly applied, but still there are so many better metals, that cast iron would not be the one that I would select. Cast iron has not been properly applied yet, according to my notion, but if it were properly applied, it might be turned to very good account if we could not get something better, but we do know of something better.

2334. At present you think that it is not the best material?—It is not.

2335. What advantage does bronze possess?—Bronze is a very excellent metal, but it has some faults. We sometimes get it up to 17 tons of tenacity, which is nearly double that of cast iron, but then it is softer than cast iron, and is not half so good in that respect. As compared with wrought iron, we get wrought iron up to 25 tons, but that depends upon how we apply the wrought iron. The bronze has a tenacity of from about 11 up to 17 tons. It is very bad when it is at 11, which is the case when it has been cooled very slowly; it is a bad thing to cool brass slowly, but if it is managed nicely, you can get it so tenacious that it takes 17 tons to break it, and with a great deal of elasticity.

2336. Is bronze at all comparable in a practical point of view with wrought iron for small guns, such as field guns?—It all depends upon the way in which it is applied.

2337. At any rate it has not been so well proved

as wrought iron for large guns?—It is a very trusty metal, and you may put great confidence in it. In the case of a wrought-iron structure, there is always an uncertainty in regard to the strength of the welds; if the iron is of a higher quality, that is to say, near steel, the welds are very much lower than if it is of lower quality; the better the iron the more uncertain are the welds, and if you happen to use in the manufacture coal with more sulphur in it than there ought to be, the strength of the welds go down at once. In the case of gun metal you will never get lower than 11 tons, and you have the 11 tons every way. And there is one most important point to be borne in mind, that if there is one part of a structure of that kind that is a little better than 11 tons, and the rest of another strength, all the going is at the weakest part.

2338. Has bronze been tried for guns of any large size?—Not much. A large gun has been made, but it has not yet been turned to account. One of the Armstrong guns was bouched with a brass lining, but it did not answer well, it pushed forward.

2339. (*Major Young.*) With regard to the bronze, have you made any experiments, or are you aware of any experiments having been made in this country with the new metal, the Austrian metal?—Yes; I have made a great many experiments myself, I procured some of that metal from Austria as well.

2340. What is your opinion of that metal?—Its mechanical properties are very high, but 12 years ago some one brought forward a Muntz metal gun, which was almost the same as the Austrian metal. That gun was tried against an ordinary bronze gun, but it very quickly went down, the zinc began to run out of the metal and the gun was rendered useless.

2341. (*Col. Simmons.*) What is the composition of the Austrian metal?—Almost the same as the Muntz metal—60 parts of copper, 40 of zinc, 4 of iron, and 2 of tin.

2342. Is that the composition of the metal?—The Muntz metal is without the four parts of iron and the two of tin; it is composed of 60 parts of copper and 40 of zinc. With regard to the Austrian metal,—the Sterra,—some very curious results come out in using it. I do not know whether it is known elsewhere, but I have found that if I can manage to make it cool the instant it is put into the mould its tenacity increases very considerably; it goes up from about 20 tons to about 25 tons, both being poured out of the same pot, the difference being caused by making the one casting in a sand mould and the other in a chilling mould.

2343. Which of those two castings produces the 20 tons?—The one that is cooled slowly in the sand mould, that stretches very much and has a wavy appearance when it stretches.

2344. (*Mr. Pole.*) Does the zinc come out of that metal?—It did in the Muntz gun; that gun was a failure before it fired 150 rounds; whereas a bronze gun would have gone on *ad infinitum*.

2345. (*Col. Simmons.*) That gun was without the ingredients of iron and tin, was it not?—Yes.

2346. Do you think it possible that the addition of those materials might prevent the exuding of the zinc?—I have not the means of giving an opinion upon that at present.



2347. (*Mr. Pole.*) Does not the exuding of the zinc show that there is a want of true chemical combination?—That may be so.

2348. There are two principal modes of making wrought-iron guns, namely, by solid forgings and by building them up; have you seen much of the method of making guns by solid forging?—I have seen a good deal of that method.

2349. What is your opinion of that method of making wrought-iron guns as compared with the built-up guns?—That question opens up a very large subject, upon which there is an enormous deal to be said.

2350. By the building-up method we will understand at present what is known as "the coil principle," of which you have had very large experience; can you give the Committee in general terms an idea of what the chief advantages of that coil principle are;—I have made nearly 2,500 built-up guns, and of that number between 600 and 700 with a core on the solid plan, which has been referred to; the remainder have been on the coil plan. I will give the Committee the history of our experience. When we first began, we were under the impression that the coil was nearly as strong one way as the other; it had not suggested itself that the coil was weaker one way than it was the other, but on going to proof and after a little experience we began to find out that the guns were weak in a particular direction, and on experimenting with pieces and testing them by pulling asunder, we began to find out that the small sizes of coil would not weld up to more than 10 tons per square inch, whereas in the other direction the strength is 25 tons per square inch. With a small coil we cannot give the metal a blow that will drive the surfaces into each other, we can only pat them down to lie close, there is not that rigidity in the structure to receive a good blow.

2351. In the ordinary welding can you get as high as 22 tons?—Yes, if you scarf the surfaces, and so make them pull across each other, but if we only butt them together, any blow which you can give a light structure of that kind seldom gives above 14 tons, at least I have not been able to do so. In order to get really good guns free from defect inside it is necessary to have a pure iron, and the purer the iron the more difficult it is to weld it properly, and whenever you use an iron of that kind there is a tendency to blister inside when you come to make the coiled structure for the inside of the gun. With this chance of defects it is a hard matter to get the guns positively perfect. We went on making the first 12-pounders entirely upon the coiled plan, and we made some 350 or 360 of them, but many had to be bouched. A solid inner tube was tried, and 100 of them came back from proof perfect; 255 have been made on that principle, and there has never been a complaint. The reason why the former ones gave way is probably this, that although the coil may have an average welding of 10 tons, there is some little bit only of seven tons, and that little bit opens, and the gun is a failure.

2352. Will you describe what construction you refer to now; you do not mean, do you, a gun made entirely of one solid piece?—No.

2353. Do you make No. 1 coiled or solid?—Merely the internal lining is solid, a solid forging bored out. I will explain why that turned out so well. If we had gone to work piling the iron in the ordinary way slanting on bit after bit, we should have had more defects than we had with the coil, but the way that this internal part was made is this. A large lump made up of three slabs was well hammered into one short lump, and then, after it was completely welded in that way, it was drawn out in this manner (*describing the same*). The advantages of that process were these, that those welds gave 22 tons before being drawn out, and then by drawing out I spread those welds about so (*describing the same*), and it turned out well; it has been a very successful gun

indeed; 255 of that gun have been in the service, and there has been no complaint of them.

2354. (*Col. Simmons.*) Can you cut up this iron in any way?—Yes; whenever there was a bad gun I always cut it up. I have made between 2,000 and 3,000 experiments.

2355. What strength can you depend upon in that tube to the square inch?—About 22 tons; sometimes up to 24, but seldom much under 22.

2356. (*Col. Taylor.*) What was the thickness of the coil itself?—About one inch and a half, and that is why they turned out so well. I have said that there are 255 in the service, but there are very nearly 700 with the 100-pounders and 20-pounders; but the 100-pounders were objected to; they were said to score, and there was an order not to put in any more.

2357. (*Mr. Pole.*) How was the grain of the iron laid?—It was pressed down into a solid lump and then elongated out into a tube by hammering and working, then having to bore out the interior, by that means we got obtained a shell (it was only a shell that we wanted), and it was about 22 tons strength in every direction.

2358. Was not that longitudinal direction of the fibre the cause of the guns scoring by the action of the powder?—The mischief produced by that scoring was nothing compared to the opening of the welds. (*The witness here entered into a detailed description of the gun upon the drawings.*)

2359. You have been describing to us the coil system generally, and you were drawing a distinction between the manufacture of the inner barrel by coils and by a solid forging; will you describe the kind of forging that you made for the barrel in the way you think has answered best?—I was describing the advantage of the coil, that it was strong in a circumferential direction in that, it has the full strength of the iron, and that is a great deal; but no inference must be taken against the coil principle from anything that I may say on this subject, because I think it very good for other parts of the gun though I do not think it is right for the barrel, and the reason why I think it is not right is, that the barrel must be perfect inside, and there is no material like wrought iron, holding the rubbish which it often does, can be made perfect without an enormous deal of wasting to get at positive perfection; and then there are these blisters that I spoke of, and the imperfection of the welds which it is liable to have, and that will always make the coil inside the gun weak in a longitudinal direction. After the 350 or 360 guns that I have mentioned were done, some 12-pounders with a solid inner tube were made at Woolwich; 255 of them were made, and with the exception of three every one that came back from proof was right the first time without having to be repaired, and the way in which that inside was forged was by piling three lumps one above another, forming them into a short piece, and then drawing it out in the direction of the length of the gun, so that the welds were transverse to the axis.

2360. Whereas in the ordinary mode of forging which is called faggotting, the welds would be parallel to the axis?—Yes, but what I consider to be the secret of success in this plan is that the iron is thoroughly welded before it is drawn out; when it is a thin coiled structure you can only get a moderate blow; you knock it out of shape if you give it a really good blow that would send it properly home, whereas you can do so in this way. It is not nearly perfect I must admit, but still it is moderately good, and for the inner barrel better than coil.

2361. (*Col. Simmons.*) What tensile strength do you require in iron so welded and so drawn out in this particular solid core?—Just in the vicinity of 22 tons in every direction, and through the welds too.

2362. (*Major Young.*) What do you consider would be the strength of the coil in every direction?—In a circumferential direction it is sometimes up to 26, but the longitudinal averaging from 10 to 14.

2363. And the loss in the circumferential strength

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in this solid boring would be only in the proportion of 25 or 26 to 22?—That would be about it; but in the other direction you gain enormously; you gain 10 tons, and you have it uniform. If there is one point above another which I consider important it is uniformity; if there is one part of a gun a little weaker than the other, all the stretching takes place at that weak part, and that is the history of many mishaps which take place with those guns.

2364. (*Col. Simmons.*) You stated that out of 255 12-pounder guns that you forged solid, only three were wrong at the first proof?—Only three.

2365. In what way did they show it?—They gave way because the iron was not properly welded.

2366. You had constructed previously to that, had you not, a large number hollow, entirely upon the coil principle?—Yes, 360 odd. When they came back from proof at first they had those defects inside, and it became a very serious question as to what was to be done with them. The inside of the gun must be perfect, and if you look at the drawing of that particular gun you will see where the difficulty lay. (*The witness explained the drawing.*)

2367. Of those 360 guns how many were sent back after the first proof to be bouched?—I think we have bouched about 160.

2368. What was the nature of the repair that you had to effect in those 160?—If it was a defect somewhere in the vicinity of the breech we would not bouch it all the way; we merely put in a short tube. There never was better work made in England than the putting in of those tubes; we ground them up to the 1000th part of an inch in every way, and pushed them in with the hydraulic press. The tube had to be small enough to go into the screw of the copper bush; and if it was made large enough to take the screw you hardly left anything in the gun itself, and the whole structure would have failed. The right course would have been to have condemned the gun and made a new barrel entire. It would have increased the expense only a little, which is the present course.

2369. Have those 160 guns required to be repaired since?—Three of those that we have been speaking of are pronounced unserviceable; they have given way in various parts, but not any of them in these bush tubes. I have some drawings here of the way in which I mended some of them latterly by putting in a screw at this end (*pointing to a drawing*), to prevent the tendency to go forward; with a new barrel they will again be serviceable.

2370. (*Major Young.*) All the present field guns are made upon the coil principle, are they not?—Yes.

2371. How do you account for their succeeding better than they did in the first instance?—They do succeed better now, because made in a different manner. After 150 of them in this particular way, we made them with two coils in one, this is an improvement. The defects of the original plan were considerable, because if there was a weak point it would open. It was then resolved to make the two coils in one; we were able then to give it a stronger blow, and so got up to 14 tons by this change.

2372. (*Col. Simmons.*) In speaking of the strength of the weld as 14 tons, do you apply that to the weld where two sections of the gun come together, or do you apply it to the weld of the coil itself?—Suppose I cut a slice out in that direction (*describing the same*) and then pull it asunder through the welds, at the highest point, while the strength of the iron is 25 tons, the weld is 14 tons and down to 10 or even less; but of course the weakest point goes first.

2373. Do you find generally any difference between the welds in the coil itself and the weld where you bring the two cylinders together?—The strongest part is where we bring the two cylinders together. There is just one thing against us there, and it is this, that in trying to weld a large mass all at once there is a great difficulty in managing the fire; if the mass heats too fast or too slow it becomes injured,

and there is another kind of difficulty which arises in rendering the iron granular, but when it is done right it is better than the other parts, always being about two tons stronger.

2374. Were the repairs which were done to those 160 guns very expensive?—It does not much matter how expensive they were when I say that the expense altogether of the entire number of 364 guns came to 83*l.* odd a piece. The estimate that was given for them before we began was 200*l.*, and the entire lot were finished for 83*l.* a piece; all the expenses connected with them were included in that sum. If we had condemned them and put in new inner barrels, the entire number would have been made for half the estimate, and this can yet be done.

2375. I presume that that was merely the expense incurred in the factory?—The material and expenses and interest on plant and everything of that sort.

2376. Without any profits of trade?—No profits of trade are included; we just give the precise cost.

2377. (*Mr. Pole.*) Supposing that the barrels were what you wished, are you satisfied with the efficiency of the coiled principle as a mode of construction for the outer parts of a built-up gun?—It is very safe for the outside of the gun.

2378. It has a great advantage in point of strength over a solid forging, has it not, by bringing the strong direction of the iron circumferentially?—Yes, but it is weak the other way; but at the same time, for the outside of a gun it answers very well. There is one advantage about it, that it is very sure, and so far good in a circumferential direction, although it is not so strong in the other.

2379. In fact you get the whole strength of the iron applied in the direction to resist the strain of the powder, which has a tendency to burst the gun?—Yes.

2380. Is not there also an advantage in using small bars of iron; is it not the fact that in the iron manufacture, by getting bars of a comparatively small size you are enabled to ensure a stronger iron, and a sounder iron, and a better quality of iron than by using iron in larger masses?—Yes; but you are sure to lose that advantage again; you cannot give it a blow that will weld it properly, and anything that is gained in one way is more than lost in the other. I prefer a good stiff bar so as to get a blow at it.

2381. Comparing this principle with solid forging, by getting iron in bars you are able to ensure getting iron of a better quality than in a larger mass?—Yes; if you go to very small bars you get 26 tons, whereas in the same iron with a larger bar it would be about 25½ tons. Of course, on the outside it is a little stronger, but it is a little weaker in the centre.

2382. You can depend on iron bars, because that mode of manufacture enables the iron maker to make it of a more trustworthy quality?—Yes; a large forging of wrought iron will not answer for guns, because the inside has always small clefts here and there, even if you do your best to get it perfect.

2383. But merely speaking of the advantage of the coil principle as compared with solid forging, you are enabled, by using small dimensions of iron, to ensure that the iron shall be of a better quality and more trustworthy; in fact you can see, as it were, into the interior of what you are making?—Yes.

2384. You are enabled to ensure a better quality of iron than you could if the whole thing was formed in one mass, and to ensure that the strength of the iron shall be applied in the most beneficial direction?—Yes.

2385. And it also enables you, does it not, to put the grain of the iron in different ways in different portions of the gun; for instance, in the breech piece you dispose of the grain of the iron lengthwise, and the strength that is required is in that direction?—Yes, it is just exactly in that direction about 22 tons, in the larger the weld is about 14, and in the smaller ones about 10 tons, and sometimes lower.

2386. In this method of building up guns you make this breech-piece by a solid forging, do you?—



Not in those guns that we have been speaking about, it was made in another way, not nearly so good.

2387. How is it made now?—The fact of these guns having always been wrong about the breech screws was owing to certain causes. The breech piece of the gun was made by taking two shells like this (*describing the same*), and they were laid on to each other and welded with a V piece. You will easily see from what I have been saying about the welding of the coils that it is just as difficult to get a good blow at this, and the consequence is that no amount of care will ever make that a good sound piece of forging. Whatever plan may be resorted to for doing it by welding, we cannot get a blow to make it a good sound thing. The grip of this part was not 10 tons per square inch in welding the two semicircular shells together.

2388. (*Col. Simmons.*) That would have reduced the circumferential strength to 10 tons?—Yes; and the consequence was that in putting them on to the gun, if they were less than 10 tons they split, and some of those I have not a doubt were near splitting, but they did not split being held fast by the outer coils. Those two coils (*pointing them out*) are just the salvation of that gun, and if we were to dismember them now I expect we should find some of them split.

2389. Were those 12-pounder guns?—These were the first 12-pounder guns, and then having to face this difficulty from month to month the question was raised again and again whether it would not be better to make it a solid and bore it out. If that were done the iron would not be lying in the proper direction, it would be about 22 in that direction, and we should have 22 in the other direction, and we should get a 22-ton grip. Now that plan of having a solid has answered well. It is not perfection by a long way, but it is very much better both for the breech and the inside of the gun.

2390. Do I rightly understand that all your 12-pounders are forged solid in the inside?—The whole of the 255 12-pounders for the sea service were made with a solid tube, and there has not been a single failure except the three which I mentioned; but there are a number of points of difference between them and this gun upon which its success is dependent.

2391. (*Mr. Penn.*) Do I rightly understand that originally the inner tubes of those guns of this particular size were coiled?—Yes; they were made of coils in this way, a seven-eighths of an inch substance on inside and an inch substance outside up to this point (*describing the same*). The strength of that gun, supposing this not to be such a grip as to hold it, all came upon that (*pointing to a part of the drawing*). Supposing that that gave way there was nothing but the grip of that trunnion to hold it, and if you take into consideration the leverage of a gun of such a length, in the event of that part being not very strong, say seven tons or even up to 10 tons we can easily see that it would give way there.

2392. This is merely butted, is it not?—No, it is not butted at all; there is no hold there.

2393. The whole length of this tube is held simply by the grip of this short piece?—Yes, by the grip of this seven-eighths of an inch; I was explaining before you came in that we made 255 guns with a solid forging and we have never had a single complaint about them.

2394. (*Col. Simmons.*) Since you completed those 255 guns have you continued to forge them solid or hollow?—I have made 202 20-pounders solid, and have never had a complaint of them since they were issued.

2395. Were all those 202 20-pounders passed at the first proof?—No; I have a statement here of Armstrong guns issued with solid inner tubes, from which it appears that of 202 20-pounders issued for service none have been returned for repair and of 239 110-pounders eight have been returned for repair.

2396. Were those eight returned after proof or after they had been issued for service?—After they had been issued for service.

2397. (*Col. Ormsby.*) Are you aware whether those guns which you are speaking of and as to which there have been no complaints in the service, have been much used in service?—I cannot inform you; I should like to find that out. The gun that I should like to know best about is the sea service 12-pounder. I know that one has fired 300 and odd rounds at Woolwich in trying to burst it, but it remains as good as ever and that was one of the guns in the Exhibition, but I do not know the history of the others; if you happen to have any bad ones you generally hear of them pretty quickly. There are five points of difference between those two guns that make the one good and the other not so good.

2398. (*Col. Simmons.*) Will you state those five points briefly?—One of the chief points of difference is that the one is made with a coil tube and the other with a solid tube, and that, owing to the circumstance that the strength is about 22 tons in the longitudinal direction in the one, and in the other only about 10 tons, there is that important advantage attaching to the solid tube. In the second place in the sea service gun, which I have here (*pointing to a drawing*), you see that it is a foot shorter in the chase and consequently the tendency to yield in any way is very much decreased. The third point is the greater length of the coil in advance of the trunnion, which is a great support. The point about those guns which there has been the most complaint of, and which has never been right, and never will be right, is the breech screw; they are always breaking at one place. In the one gun, after making allowance for the end of the thread both ways, the length of the screw is about five inches, in the other gun it is seven inches, allowing a quarter of an inch for the thread at each end. Now if seven inches is required, we may be quite sure that five is not enough; I do not think seven is enough, but seven inches does not break, whereas five inches often breaks. And then again, that seven inches has an angular thread, that is to say, instead of being square it has the top of the thread cut away so as to allow the base to be much broader, and the strength is increased from 20 to 25 per cent. by that means, and that enables it to stand, whereas those five inches with a square thread never did stand.

2399. The fourth point I presume is the longer breech screw and the improved form of thread?—Yes; then there is another thing which I should mention, that those breech pieces which are made of those two thin shells by having to be put into a great fire so often, in order to weld those long surfaces, get into a very granular state before we have done with them, and instead of having the grip and strength of the iron, I do not suppose they have more than about half. This gun (*pointing to a drawing of the land service gun*) was made of two thin shells; there is no abutment in welding it, and a mandril put into a thing of that kind will cool it so much, but the worst was putting it into the fire so often, that affected the iron; but when solid, and with the screw seven inches instead of five, the gun was a different thing altogether, and there has been no complaint.

2400. Then the fifth point is that the breech piece, instead of being made of two half cylinders, was forged solid and bored out?—Yes.

2401. Since those 255 guns have been made, have all your 12-pounders been constructed on the same principle?—There have been none at all made for the land service since we made the 360 that I have mentioned.

2402. Have you made no 12-pounders at all at the gun factory since then?—No.

2403. Then you have made only 600 or 700 12-pounders altogether?—Not quite so many as that.

2404. How many 12-pounder guns are there in the service?—Taking them altogether for land and sea service there are only 625.

2405. (*Col. Taylor.*) Those were made in the Royal Gun Factory but others were made at Elswick

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were there not?—I do not think that more than 65 were made at Elswick.

2406. (*Major Young.*) In the horse artillery guns which have been made since that time, you have adopted a different plan, have you not?—It is a different construction altogether.

2407. (*Mr. Penn.*) Taking the 12-pounder gun as you last made it for the sea service have you confidence in it, do you think it is a well constructed gun?—It is a very good gun, but I should like to see it made of steel inside, and I should like other 3 inches at the end of the screw, or if of this length, then of larger diameter.

2408. Do you consider that steel has attained that precision that you can trust it?—I would venture to use it; even if it is not perfect. I believe that the time has come when if we persevere with some of the best houses we shall get them to produce a uniform quality, and if we can get always what we get almost always we shall get a perfect gun. I have a 110-pounder which was damaged and put a steel lining into it and fired it nearly 200 proof rounds for proving the vent pieces, and the inside is just as perfect as when it was first made.

2409. Your idea of a perfect 12-pounder would be a gun with a steel lining, and with that addition to the breech which you have mentioned?—Yes.

2410. (*Col. Simmons.*) Have you a statement of all the Armstrong guns made at the royal gun factories?—Yes.

2411. Would you hand it in?—Yes, I will do so. (*The witness delivered in the same.*)

2412. (*Major Young.*) With respect to the steel lining, is it to be of the same size as what you call the A tube?—Knowing the amount of mischief which arises if anything goes wrong, I should be afraid to venture too much steel into a gun at the present time till I had really proved it to be sound and good. The right thing to do is not to venture much, but to apply it to that for which we know it would be a great improvement, and to trust for safety to the coils outside; if it does burst it will not kill a man; it will only break up the inside, and nobody would be killed.

2413. (*Mr. Pole.*) That is one great advantage of the coil principle, that it gives security to the gun?—Yes. If a steel gun were to burst, it would be a very dangerous affair. I could not venture to recommend guns to be made entirely of steel in the present state of its manufacture.

2414. Do I rightly understand that you would always have a doubt about a steel lining?—I would have no doubt about steel lining; I would venture at once upon it, and take the blame if it did not answer, but I would not venture upon steel for an entire gun for fear of accidents.

2415. (*Mr. Pole.*) You think that the coil principle, as applied to the external portion of the gun, gives a perfect and absolute security to the gun against bursting?—Yes; I like it for the outside.

2416. You have no doubt about this?—We have seen some built-up guns that were knocked to pieces even with the coil on; but still it is a great protection, no doubt.

2417. Is it not a feature of the coil principle that it gives way and shows its defects before the bursting actually takes place?—In a built-up gun you begin to see the coils pulling out of each other, there is no doubt.

2418. (*Col. Simmons.*) Your answer with regard to steel not being sufficiently perfect to construct a gun of it entirely applies to your knowledge of steel at the present time; but the manufacture of steel has made great progress of late years, and do you not think that we may look forward to steel arriving at such perfection that we may possibly be able to make guns entirely of steel?—I fully believe that we are close upon it, but at the same time I have had so many promises with regard to the quality of steel for the last four years, and have still found it not what it ought to be, and liable to break occasionally, that I have not

implicit confidence in it, judging from my own experience; and I imagine that we have had more experience than a good many. We have had our vent pieces and breech screws of steel, and we have gone to the best makers and paid the highest price.

2419. (*Mr. Pole.*) What would be the advantage of steel in constructing a gun? It might enable you to make it lighter in consequence of its tenacity, but are you not forbidden by the necessity of having a certain weight as regards the recoil?—No, it is not in that respect that I look for the advantage of steel. We get a perfect and a hard inside, and an inside that will not be injured much by shells. There is all that in its favour, and besides we have its full strength in a longitudinal direction and in a circumferential direction; but above all we have a uniform strength, and consequently there is not a weak point for the elasticity to do its work in a short space.

2420. (*Col. Simmons.*) You get rid of welds?—Yes, the welds generally are the weak points. There is no satisfaction in your guns coming back from proof disabled and having to be bored out and retubed again.

2421. (*Mr. Pole.*) Are not the advantages that you have just mentioned sufficiently attained by having a steel barrel?—Yes.

2422. Would there be any advantage in using steel for the entire gun if you can get the advantages of steel for the barrel?—It would be a much simpler gun if it were one entire mass, and it would be a better gun if we had faith in the steel.

2423. Would it be cheaper?—I do not think it would be cheaper.

2424. It could not be lighter because you must have a certain amount of weight as regards the recoil, must you not?—Just so. We shall come to steel inside very soon.

2425. Is there any probability of making the coils of steel, and would you wish to do it if you could?—No one would do it.

2426. If you adhere to the coils they must be of wrought iron?—Yes.

2427. (*Commander Singer.*) With regard to the steel lining that you would wish to see, would it be a casting?—Yes, a casting bored out.

2428. (*Col. Taylor.*) In casting steel, how do they prevent the formation of air bubbles which is always a difficulty in casting iron, because you might have one of those air bubbles in a very important part of the gun?—In a cast mass you would always have air bubbles; it is the hammering that obliterates all that. If you take a rough cast of steel you will almost always find some little specs, but with very careful management there are very few at present, compared to what there used to be, except at the end of the casting which is always cut off.

2429. (*Mr. Pole.*) You have arrived now by your experience at a perfectly practicable way of managing the manufacture of guns on the coil principle, have you not?—Not for the inside of the guns.

2430. Always putting the barrel out of the question, but as regards the outside of the guns, there is no difficulty in the manufacture now either in the construction of the coils or the manner of putting them on?—No, none.

2431. And it is not a very expensive mode as you do it now, is it?—Not very.

2432. We all know how very expensive large forgings are compared with small forgings. Could you give any idea of the comparison between the expense of a built-up gun and that of a solid forged gun?—If it was a question which should be ready for proof with the smallest expense, the solid forging would be first, but the built-up gun would win the race, and not have so many bad ones as with solid forgings; it would not have so many holes developed in the vicinity of the bore.

2433. (*Col. Simmons.*) That would depend very much upon the manner in which the solid forging was fired, would it not?—Yes. But still having to deal with a large mass and the great heating that the



thick part gets, it somehow tears off in the inside That happens in the cooling. It would be just at the end that you would have the trouble, not at any other part, if it was a 7-inch bore. Sir William Armstrong's wedge guns have a small hole in the breech piece the size of the projectile; in the screw guns the hole is the size of the screw. The man that makes them I dare say is the first forgerman in England, a Mr. George Taylor at Leeds; that man himself goes into the forging of those things, and I have had 30 bad ones sent back to him. I know he does his best. It is all owing to the little hole; the hole having to be but five inches, you come upon those defects. I will not have them with any defect, and I send them back. If we could bore it out seven inches it would be right, but he has tried everything and cannot do it uniformly. That is why I think we can never get satisfaction in solid guns.

2434. What gun are you speaking of now?—The 70-pounder wedge gun. Looking at that mass and the comparatively small hole there is in it, there is frequently some little defect or other in it. And if we take the other gun, where we have to put the screw into it and get all the substance out, we can be perfectly certain about the result. We have had to make about 100 of the 70-pounders, and I have sent back nearly 30 of the breech pieces.

2435. You are aware that guns of that size have been forged solid?—Yes.

2436. Do you remember any of that size being forged solid without a defect in the breech being discovered?—All of those that have come through my hands have always had that hole in the centre.

2437. Do you remember a gun which I made myself in 1851,—a solid iron forging; was there any defect in the breech of it?—I do not remember that there was. It did not pass through my hands particularly. "One swallow does not make a summer;" and when we see the great difficulty that the best forgerman in England has experienced in solid forging, one cannot help having doubts about it.

2438. That was the second gun of the sort which was forged, and if that and the first had no defects, one might infer that it is possible to make others?—It is quite possible, no doubt, but they must be always perfect.

2439. (Mr. Pole.) You agree with engineers that although good ones can be made, yet large solid forgings are not always trustworthy?—Just so.

2440. You cannot ensure solid iron to be quite perfect?—No. In the event of making steel linings to guns, I would have them all cast 6 inches longer than the gun, and experiment with every one. I would not put one into a gun until I had found out all about it.

2441. (Col. Taylor.) With respect to those defects in large forgings, have you always found them in the centre or have you found them near the surface?—Never near the outside.

2442. You may reckon on finding them in the centre?—Yes; and if you were to go into the factory you would see that the pains which the makers take to make the work good is very great indeed; in fact, it is not to be done better. You may get good ones sometimes.

2443. (Mr. Pole.) Is it not a great advantage in the built-up principle that it gives great facility of inspection and of examining the gun in every process during its manufacture, to ensure its good quality or to cause the rejection of it if it is not of good quality?—Yes, the right quality of steel; and you have faith in it; it would be better than any other principle.

2444. In a solid gun you cannot get to examine it, and you must trust entirely to faith, whereas in a coil gun you can actually see into it, or you can submit it to inspection and reject it if it is bad?—Yes.

2445. (Col. Taylor.) Supposing that the weakness of a solid forged gun was such as to cause its bursting, would you not, as a general rule, find that gun burst without giving you any warning whatever?—Yes.

2446. You would not have any preliminary sign of

weakness?—Just so. I do not think that solid forging for a gun is the direction at all which a future gun would take.

2447. (Col. Simmons.) Since the construction of those 12-pounders and 20-pounders which you have made solid, have you been continuing to make any 9-pounder horse artillery guns?—No; they are made in another way.

2448. Are they made solid or hollow?—They are made with a coil in the inside.

2449. Are they made with a small bore and then bored out to a large bore?—No; they are the same size in the bore as the 12-pounder; it is made in the original way, but it is a better gun than the 12-pounder a good deal.

2450. This gun is made as a coil gun, hollow, is it not?—Yes, it is made out of a thickish coil, so that with a mass of this size (*describing the same*) you can get well on to 14 tons by that means. There is a good long trunnion in that gun, and a good strong breech piece, and a good long screw in proportion, and it is a better gun than the original 12-pounder.

2451. Have you had many of them fail?—A good many failed at proof, from specks in the bore, but then without a moment's hesitation I put in a boring bit and bore it out the whole length of the tube from the breech piece to the muzzle.

2452. In fact you take away about half the gun, or perhaps more than half, and replace it?—Yes, we put in a new inside.

2453. (Col. Taylor.) In the event of a horse artillery 9-pounder breaking and being repaired, what is the process by which the gun is renewed?—We bury the gun in sand up to the part where it is injured, and we make a conical hole and get a ladle full of metal and run it in quickly and have the gun suspended, and the outer coil stretching for an instant slackens the whole thing, and the outside of the gun stretches before the heat comes to the inside.

2454. (Col. Simmons.) What is the expense of a repair of that sort?—We do not keep an account of that; we put it all down to the order for the guns, and then at the end of the year we see what the guns cost. We do the whole by piecework, but still that makes no difference.

2455. It would come to nearly that 83*l.* which you mentioned with regard to the other guns, would it not?—No, those guns do not come to so much as that.

2456. What is the cost of the 9-pounder gun itself?—I could not say off-hand.

2457. (Mr. Pole.) That 9-pounder is a more modern gun than the original gun, is it not?—Yes.

2458. And you have the advantage of longer experience?—Yes; it is a better gun in every way than the original one.

2459. (Chairman.) Have those guns been made subsequently to the sea service 12-pounders?—Yes, they have; Sir William Armstrong never liked the solid inner barrel, and I was always very much obliged to him for allowing me to use it, but he did allow it. They never used it at Elswick, and after a time Sir William did not like this scoring that I referred to which occurred in one or two guns, and on account of that scoring an order was given that no more was to be done, and that stopped the matter. We have adopted this plan ever since, and if the inside is defective we bore it out and put in another inside.

2460. (Mr. Penn.) What do you mean by scorings?—It was said that there were certain longitudinal scratches appearing in the powder chamber, but it was not very much. There was a great deal said about it, that these guns were not turning out well, and that Sir William Armstrong had been obliged to stop the making of them in that way; and we were stopped by a positive order.

2461. Are you speaking now of the period when you made the barrel all one piece?—Yes; before you came in I was explaining to the Committee the way in which we made it, and you will see the advantage

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of that. We made a thick lump that we could get a really good blow at, so as to weld its surfaces, and then we drew it out in a longitudinal direction (*describing the same*).

2462. (*Mr. Pole.*) So as to bring the weld transverse to the barrel and not longitudinal to the barrel?—Just so.

2463. (*Col. Simmons.*) Of those 161 9-pounders which appear in this return to have been made at the gun factory, how many of them were sent back for repair after first proof?—There is not much value in this answer, because the only question is how much does the gun cost. Those that have gone to service are really good when they go, and the question is how much does it cost to make them so good, even if we made them six times over, that does not so much signify.

2464. It is not so much a question of cost as of comparison between the solid and the coiled forging?—Yes.

2465. There were 63 land service 20-pounders, were they forged solid or coiled?—I am not quite certain.

2466. (*Col. Ormsby.*) From your experience in the manufacture of Armstrong guns will you state which you think is the best mode of making them in the inner barrel, would you have solid forgings or would you have them entirely on the coil system. I am speaking now of field guns?—I do not consider that the solid forging is by any means perfect yet, but owing to the reasons which I have already pointed out, I consider that for the inner barrel a solid forging is very much better than a coil, but neither so good as steel.

2467. Do you think that a solid forging for the barrel is the best plan you could adopt for the present?—No.

2468. Will you state what is the best plan?—I am prepared to venture on a steel barrel. From the experiments that I have been making during the last few months, I am quite prepared to recommend a trial of steel, and if we are driven from that it would be a very great misfortune, for neither the coil nor the solid forging is perfect, but the steel would be perfect in every other respect if it will stand, and I believe we have now a method of treating it that will enable it to stand, and by having it cast six inches longer than we want it, we shall easily know whether a certain piece of steel is of that quality which we can rely upon.

2469. (*Mr. Pole.*) Would you for security's sake put a little heavier coil over the barrel of the field gun than is put on at the present moment, seeing that there may be doubts about its circumferential strength?—I am not sure about that; I would like to put longer coils than there are on those points (*describing the same*).

2470. So as to overlap the steel barrel?—Yes. Until I had perfect confidence in the steel I would put it on to intercept the pieces from flying if the gun did fail. If a few steel guns were to go there would be a great outcry against them.

2471. Is wrought iron sufficiently hard for the rifling to stand the wear that comes upon it?—It is pretty well, but it is not nearly so good as steel, it is not much better than cast iron in that respect.

2472. Is the wear of the internal barrel of the gun considerable?—I do not think that that is one of the points that will ever come to be a serious question. There is something very wrong if you see much symptom of that; if you have very little bearing surface, of course these surfaces having a deal of work to do, must soon show symptoms of wearing, but where there is a large surface, as in Sir William Armstrong's many grooves, or in Mr. Whitworth's, or in others, there is plenty of surface to do that part of the work.

2473. (*Col. Simmons.*) You do not anticipate that the interior bore of an iron gun would be damaged very much by the friction of hard metal shot in passing down the bore, or not much more than if the

shot was coated with soft metal?—I do not think that that will ever be a grievance. Just consider how much one hard substance will act upon another before you see any perceptible wear. I do not expect that the gun will ever wear out in that respect.

2474. That depends a good deal, does it not, upon the amount of bearing surface which the gun would have?—Yes; the more bearing surface the better.

2475. You are acquainted with the Whitworth form of bore, do you think that the bearing surface in that case is sufficient, and that you would not anticipate any injury to the interior of the bore from friction?—No, I do not suppose there would be any injury from that cause.

2476. (*Major Young.*) That will depend a good deal upon the fit of the projectile?—Yes, and it depends a great deal upon the twist; Mr. Whitworth's has a very rapid twist and of course the friction is in proportion to the twist, but the surfaces are very well arranged, they do not wear, so far as mere wearing is concerned, but I do not consider that that will ever be found to be a disadvantage in any gun; if you were to go down to very little surface it would be a very serious matter.

2477. (*Col. Simmons.*) Is there much difference in the strength of the gun itself to resist bursting produced by the different methods of rifling?—We see how well the Lancaster stands and that has the greatest tendency to burst of any of the rifled guns. I do not think that much importance is to be attached to that, and I consider that any of the kind of guns that we are speaking about, even the Lancaster gun, would not burst, and hence, if I am correct in that, the measure of strength in all the others is ample; if you measure these guns very accurately (*pointing to some drawings*) you will find that they are of exactly the same area in every particular.

2478. So that there is the same amount of metal in the block to be broken in each case?—Yes.

2479. The area of the block being the same and the area of the bore being the same, the area of the iron to be broken must be the same in all?—Yes.

2480. (*Col. Taylor.*) Do you consider that there is no increased weakness, we will say, in the form of the Whitworth gun from the thinness of the metal at the projecting points of the hexagon?—My experiments just shew exactly where it is. Beginning with the Lancaster gun some of them failed in the Crimea by bursting at the muzzle; those guns began with a straight line and came to a very rapid twist at last so that the muzzle had all to do when the shot was going out with enormous velocity, and then shells were made with wrought iron and welded, and I daresay many of them burst in the gun and helped on the mischief. But I should observe that that Lancaster gun was 7 tons and I believe that any one of our wrought-iron guns would stand that strain without ever calling its strength into requisition at all. Then if you take any of the others you get them three or four times above that, and hence, though I think that a very valuable experiment inasmuch as it gives us some definite knowledge, at the same time it does not help us much. The next one is 23 tons, and then when you go up to Sir William Armstrong's original shunt gun which was 25 tons, or to Commander Scott's, 27 tons, or Mr. Whitworth's 28 tons, four times the Lancaster gun, if seven is not sufficient to strain the Lancaster gun, of course the others are three or four times as strong in that particular, but it is not in that direction that the weakness lies.

2481. (*Mr. Pole.*) In fact the twisting action which you have represented can hardly come into operation to any dangerous extent upon the actual guns?—No, I do not think it can; still it shows the strain that there is upon the gun so far as that goes.

2482. (*Major Young.*) Which is the best one?—Sir William Armstrong's last with the ten grooves took the greatest amount of wear to make it split. There is very little tendency to burst in that gun as proceeding from the rifle.



2483. (*Col. Simmons.*) Do you think that, taking two guns rifled on the same principle, one having greater rapidity of twist than the other, that which has the greater rapidity of twist has much greater tendency to split than the other?—Yes; I think that the tendency is just in proportion to the twist, so far as that element goes.

2484. Have you made any experiments on that point?—No, I have not made any experiments on that matter, but I think that that is almost self-evident.

2485. Knowing the twist of the Whitworth gun as it has been constructed, do you consider that the amount of twist adopted in that gun is to such an extent as to cause you to have any uneasiness with regard to the splitting of your gun, manufactured as you manufacture it now upon the coil principle?—No, not at all. The 120-pounder down at Shoeburyness which I made for Mr. Whitworth last had not a coil inside; it was a solid inside. There are a great many good points about that gun.

2486. With iron in which you have a uniform strength of about 22 tons you would not anticipate any danger from the rapidity of that twist?—No, I can quite easily provide for the twist.

2487. (*Mr. Pole.*) You always prefer, do you not, a uniform twist to an accelerating twist?—Yes; the accelerating twist always strains the muzzle so much.

2488. (*Major Young.*) Was there anything particular about that Whitworth gun at Shoeburyness—the one that was manufactured in the arsenal; was it made exactly on Sir William Armstrong's principle of manufacture?—I have a drawing of that gun here (*producing the same*). This is the original gun which was to have been made for Mr. Whitworth. All the parts are screwed. It would make a very strong gun if you went to the expense and trouble of doing it; but the part which I do not like about it is, that instead of having the breech plugged up it should have been solid. I prefer it solid. Before explaining some of the points about this gun I should just like, if possible, to convey in a few words the reasons which have led my own mind to think well of this particular plan. In these larger guns, the Armstrong 300-pounder and so on, they have all shown a weakness from a particular cause. In that last one which was tried the other day it shows a little mark here (*pointing to the drawing*). A plug is fitted in with very great firmness into a coiled tube, and behind that plug there is a sheet of copper. When the pressure comes upon that plug it no doubt tends to compress the copper, and then that weak point in the vicinity of the plug is torn open, allowing the gas to get in and act upon a much larger area. I argue in this way: Why have the end plugged up at all? Why not put in as large a screw as you can with all the force you can bring to bear upon it, and make it butt up against the end of the solid substance, and have no joint at all? Then this occurs to me, that if we make it with a coil we are sure that the gun will yield a little, and if there is one part of the coil that is a little under 14 tons, although we cannot guess the meaning of it, it is sure to open at that particular part, if it yields at all, and then the gun is done for. I say do not let us make it with a coil at all, but with a solid tube, and butt up the breech as hard as you can. That gun at Shoeburyness is not perfect; it has attaching to it all the defects that I have been referring to with regard to a solid tube, but still it is better than the other plan. In the four guns that I am making for Sir William Armstrong, 300-pounders, I have made two in his own way, and two, but with a close coil, in my way. I have not much faith in my own plan, because it is coiled. I have as much faith in his plan with a plug, but I fear that owing to the yielding which I know will take place if there is a weak weld, the elasticity will all be spent upon that little bit, and the thing will open a little, rendering both liable to failure. I prefer solid iron. The great chance of its not going is that it is of a uniform strength throughout of 22 tons. It is not so strong circumferentially, but it is much stronger longitudinally.

2489. (*Col. Taylor.*) In the case of a solid breech how is it forged?—I bored them out of the solid, and stopped before I got to the end. In this gun of Mr. Whitworth's, in order to make a really good tube—because we felt put upon our honour—I had this end made with the very greatest care, so as to have no chance of a leak there; and it was not such a good job after all. There is some little loose part there (*pointing to the drawing*); it is not much, but still it is not perfect. If we had steel inside instead I believe it would be a really good gun.

2490. (*Mr. Pole.*) Did you forge this inside in the manner you represented, in blocks with the welds transverse?—In the same way exactly; we kept this end large, and got a good heat upon it and welded it well down.

2491. (*Col. Simmons.*) What is the calibre of that gun?—Seven inches.

2492. And what is the thickness of metal in it?—Two inches.

2493. The solid forging would be 11 inches altogether in diameter?—Yes.

2494. With your present knowledge of steel would you hesitate to put in a bore of that diameter of steel?—No, I would not. I would like the Government to be prepared for failures at first, until we get a really good material.

2495. (*Mr. Pole.*) Do the makers know in what direction to strive in order to get a really trustworthy material?—While they are watching over it themselves it is pretty well done, but in a large contract the work is apt to be given out in piece work.

2496. (*Col. Taylor.*) Referring to what you have stated about the failure of the coil, wherever there is a weak point, did you yourself see that smooth bore 150-pounder which burst at Shoeburyness after it burst?—I think I did. I have seen the present one.

2497. Are you aware what occurred with respect to the flaw in that gun?—No.

2498. The flaw was first discovered after it was fired with a charge of 70 lbs., the elongated cartridge having carried the seat of the shot very far beyond its right position. As the idea was to carry out the experiments, without reference to saving the gun, we went on to 90 lbs. of powder, and the gun stood that. We took an impression in gutta percha of the flaw after the 70 lbs. charge, and after the high charges we went back again to complete another experiment with 50 lbs. of powder, which bringing the cast-iron 10-inch shot in the rear of that flaw almost obliterated it, by forcing it up again as it were. I have impressions of the flaw after the 70 lbs. charge, and again after the 80 lbs. and the 90 lbs. had been fired with it, and the 50 lbs. resumed, by which time the abrasion had nearly disappeared. Were you aware of that fact?—No.

2499. (*Major Young.*) This gun differs very materially, does it not, from any that Sir William Armstrong has constructed?—It has two or three points which Sir William Armstrong does not approve of. The great body of the gun is coiled. I will say this, that to Sir William Armstrong certainly belongs the credit and honour of having brought forward this building-up system; but still there are a great many ways of building up. It is quite a matter of judicious arrangement of the joints whether the gun is good or bad. That gun of Mr. Whitworth's is a very good one, but I have some drawings here of some very much better guns which I have made since. (*The witness explained the drawings.*)

2500. (*Mr. Pole.*) In this gun (*pointing to one of the drawings*) you have a coil round the barrel for the whole length?—Yes; and it is all in one piece throughout. This is a 6-ton gun (*producing a drawing*); there are three guns to be made for different individuals, and this is a gun which I have submitted as being as well arranged as I can arrange it; it is 7 inches in the bore, and it weighs 6 tons, but it is the arrangement of the parts as to where it is to break which is material. This is to be steel inside

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(describing the same); you will see that this wrought iron is welded to a coil here, and that forms one piece through the entire length of the gun. If you pass to the next one you will see that this is carried in one piece up to that part (pointing to the drawing), and by these off-sets we prevent any sudden breaking here. We have this hooking on to it and coming the entire length of the gun, and then we have another hooking on to it again, and coming and hooking on to the trunnion in this way (describing the same).

2501. (Col. Taylor.) With respect to the proving of these guns, do you not consider that a gun constructed with a careful calculation of the different points of resistance required, should not be proved with charges that bring the gas when created by the explosion to bear upon a point not built to meet it?—No; nothing can be worse than proving with those heavy charges, and bringing the charge forward.

2502. (Col. Simmons.) Those three guns of which you speak are not made upon the breech-loading principle, are they?—No; they are muzzle-loading guns. There are a number of them to be made for different inventors, in order to test them. There is one for Mr. Lancaster, I believe, and one for Commander Scott, and one on the French plan, and several others. But the question raised just now is this:—I applied to have the inner barrel made of steel, but the Select Committee rather thought that it would be better to make it on the established plan. I then sent it back again, requesting to be allowed to make it a solid forging, and the reply has not come from the Committee yet. I think that it would be a good opportunity to apply steel.

2503. Your request is that steel should be applied for the inner lining?—Yes.

2504. (Commander Singer.) Is the heavy gun on Mr. Lionel Thomas's principle, a good gun?—It is a very good gun except in two or three points; I am sorry to give my answer so indefinitely, but it is such a large question that if we were to go into it it would take a considerable amount of time. It is a 9-inch gun weighing 16 tons and it is 16 feet long. It is just finished and ready now for trial.

2505. (Mr. Penn.) Has it a solid metal shot?—Yes; I do not know the weight.

2506. (Col. Simmons.) In making those three large 7-inch guns you recommend the muzzle-loading principle, do you object to breech-loading for such a large bore as that 7-inch bore?—A gentleman of high authority the other day said to me, "Why do you not bring forward breech-loaders?" I said, "I have seen all sorts of breech-loaders, and have studied them all and I understand them all; and I have never seen one sort that I know will give thorough satisfaction as a breech-loader; and that being my opinion I never will propose one, until I can contrive an arrangement more simple, stronger, safer, and more easily worked."

2507. (Col. Taylor.) Do you mean that you would not recommend breech-loaders at all?—I have never seen one that I think I should like to fight with for six hours during a battle.

2508. (Col. Simmons.) Does that apply to all calibres?—I do not know about small guns, they may do on the breech-loading principle; but with regard to the larger guns I have not seen any plan either by Mr. Whitworth, or Sir William Armstrong, or anybody else that pleases me. There are some better than others, but they all have a great many weak points, which I could mention if you go into them in the way we have gone into the 12-pounder to-day.

2509. (Mr. Pole.) Above what size would you generally object to breech-loading; would you say down to a 40-pounder?—You can manage a 40-pounder if you have a good kind of breech-loader for a 40-pounder; but there are very few guns on any plan yet which have not a great many defects even for small guns.

2510. I see you have cross-hatched the barrel, is that a coiled barrel?—Yes.

2511. In making a steel barrel would it be made

solid and would you have to bore it out internally?—I hope that shortly we shall come to casting them on the mandril and knocking the mandril out. If we could arrive at that we could put the cast on another mandril and give it a good hammering and work it up to a good quality.

2512. (Col. Taylor.) You might cool it from the centre, might you not?—Yes.

2513. (Mr. Pole.) In making your solid wrought-iron barrels you always have to bore them out; is that much more expensive than the boring that you have to do in coiled barrels?—I do not attach any value to the expense of boring, because, if you have a great many to do you can soon organize to do it for a few shillings; we can bore out those solid tubes of about a 7-inch calibre for less than 10 shillings at any time.

2514. (Col. Simmons.) Will you have the goodness to explain to the Committee any defects which you consider to exist in the breech-loading system as shown in the 12-pounder Armstrong gun of the last pattern which is adopted in the service?—As a breech-loading gun that is about as good a gun as you will get, but it has a great many faults, the joints are always wearing out, and leaking, requiring to be recoppered; and then the weight of the vent piece that has to be lifted up is objectionable, and if it is not weighty it will break. We know that the vent pieces will break if the gun is fired much, also the copper bouching in the vent piece and in the bore is very objectionable.

2515. Do you think that the screw of that breech-loader is thoroughly strong to answer the purpose for which it was designed?—I do not think so, it ought to be 3 inches longer so as to make it impossible to break.

2516. It would add very materially to the weight of the gun would it not to make it 3 inches longer?—Yes; if you make the gun on that plan or on any breech-loading plan so that it will never get out of order it would be a very heavy and clumsy thing to manipulate, I always like to take into consideration how a gun will act during the hour of battle.

2517. (Col. Taylor.) Taking that view of it in making a comparison between a breech-loader and a muzzle-loader, supposing that a shell bursts in the muzzle-loader in action (I am speaking of a shell with a sufficiently large bursting charge to seriously injure the interior of the bore) that gun is comparatively unserviceable, you cannot load it again?—I can suppose that.

2518. Do not you think that when you have a breech-loader and can see through your gun, and can put your shot in behind so as to clear away the abrasion caused by the explosion you have an advantage in the field?—Yes, that is quite correct, but still the chances of being wrong somewhere there (pointing to the drawing) are very much greater.

2519. (Col. Simmons.) Do you consider the repairs requiring to be done to this vent piece, such as from your knowledge of the men in the artillery service, would be likely to be performed in the field with facility and rapidity?—It can be done of course, if you have proper instruments and efficient men you can make a good job of it, but any one can see that this will not be a good thing unless it is positively perfect altogether, and it is very difficult to get the thing perfect. However Sir William Armstrong's is as good a plan for a light gun as I have seen.

2520. (Mr. Penn.) How do you get the bouches out?—I just bore them out and scrape out the threads and then put in another bouch.

2521. (Col. Simmons.) The tools that are required to be taken for these repairs are numerous, are they not?—Yes.

2522. (Commander Singer.) In the new pattern 40-pounder breech-loaders which have given great satisfaction is there any difference in the construction of the breech?—It is a very good principle of arrangement, but still there are defects in it.



2523. (*Col. Ormsby.*) For general service you would prefer a muzzle-loader to a breech-loader?—As regards its use in the hands of the artillery I could not give an opinion upon that. I know that at the proof we have a difficulty in getting all those parts right, but if the artillerist or the naval officer thinks that a breech-loader suits his purpose the best, the engineer can make a very good one, but not one, so far as I have seen, without a great many objections.

2524. (*Mr. Pole.*) The objections are, in fact, inherent in the principle of breech-loading rather than in the details of construction?—Yes.

2525. (*Col. Taylor.*) Admitting the impossibility of getting anything perfect, do not you think that a fair way of judging of the merits of a gun would be to take the average of a very great number of rounds and the number of accidents incident to that number of rounds and then to take also into consideration the elements of accuracy and range, which are the great desiderata for the artillery and strike a balance of the whole?—Yes, that is a question for the artillery of course.

2526. (*Col. Simmons.*) Do you make those vent pieces in the factory now?—No, we do not; we could not make them good enough. I get them now from a steel maker in Sheffield, who takes extraordinary care about them, and if there is any defect in them we send them back to him. He charges a good price for them and takes his chance of that.

2527. What is the proof to which you subject those vent pieces?—Up to this time it has been a double charge of powder for one round, but it is to be altered now. They must be really perfect to get them to stand. We use a particular kind of Swedish iron, which is brought over on purpose, and it does very well; it does not break so readily as the former steel ones did, but still there are many defect in the welds, and we condemn them if there is any defect at all.

2528. (*Mr. Pole.*) Are they forged from Swedish bars?—From a certain brand called "C and half moon."

2529. (*Major Young.*) Provided the breech screw is not home, a blow given to the vent piece is liable, is it not, to injure it much more than if it were secure?—No doubt.

2530. Then, under those circumstances, is not the system rather a bad one from the liability there would always be on service of the men omitting to tighten up the screws?—It is open to that objection.

2531. (*Col. Simmons.*) Passing on to the 20-pounder all those objections which you pointed out with regard to the 12-pounder are aggravated, are they not, in the 20-pounder?—The larger the gun is the more difficult it becomes to make it perfect. I would wish to say here that so far as the gun factory is concerned, when I was appointed to assist Sir William Armstrong, I felt proud of the honour and we set out with the determination to make a success of this gun if it were possible to do so; I am quite sure that no man in this world has ever strived more to assist another than I have done to make these things right and good in all respects, we have done our very utmost but there have often been faults found even when we have done our best with very good men. We have our best men kept for the best part of the work and we take every pains, but notwithstanding that we have been often complained of. I do not think that for a long time the workmanship will be better than it has been with us for the last three or four years. The materials may be better but I do not think that the workmanship can be improved.

2532. Have you any difficulty in finding workmen who are sufficiently skilled for carrying out this intricate work?—At first there was a difficulty in getting them together, but one recommends another, and we get them in that way.

2533. (*Mr. Pole.*) You have got rid of a great deal of difficulty by devising machinery, have you not?—Yes, but the important point is to see that this breech-loading apparatus is really a perfect thing, if

it is not perfect it is very bad, if there is any want of truth about any part of it it does not do at all.

2534. Are the vent pieces hard, as now made from the Swedish iron, or what is their peculiar quality which you consider so valuable?—They are not so hard as mere steel, but they do not break so readily as steel. When it was determined to use no more of the steel vent pieces they were put into store, and I have lately taken half a dozen of them from the store and tempered them in oil, and I find that I cannot break them; I have tried them with the cartridge some six inches from the vent piece, which is a very severe ordeal, and given them a great number of rounds, and even with that they do not break, nor can I break them under the steam hammer.

2535. What is the gun to which these vent pieces belong?—The 110-pounder.

2536. (*Mr. Penn.*) Do they undergo some preparation of your own invention?—The matter came up by Sir William Armstrong treating shot in that way. I dare say that the idea of treating the vent pieces in that manner occurred to him at the same time but the matter that I was mixed up with was more with regard to the treatment of the barrels. I proposed to Sir William Armstrong that the barrel should be made of steel and treated in that way, and I was under the impression that I had proposed it to him, but some little controversy went on about it and we have agreed to let the matter drop. As to the application of the tempered steel barrel I am of opinion that it is the right material to use; I have been speaking so strongly in favour of steel to-day, without reference to this particular application of it, but having in my mind all the time the use of this steel for the inner barrels, and I have no doubt that we shall be able to make a good sound job of it by and by.

2537. (*Mr. Penn.*) There seems to be a very small bearing here (*pointing to a drawing*), did you ever find that those parts would not turn up?—They do not do much work. If they are very carefully handled they last a little while, but there is nothing between them and the outside. Whatever strength that copper has, that is the substance between that part of the gun and the outside.

2538. Then the strain all comes upon this annular space?—Yes, it all comes on that; whatever strain there is comes through that little piece of copper.

2539. The whole force of the shot must be exactly the same as against that?—Yes, it all comes upon the screw; the thread always begins to break here (*pointing to the drawing*). It is just owing to this, that it reaches this part before it reaches the other, and it gets more of the work to do.

2540. (*Mr. Pole.*) Do you find that to be the case with the new oblique-threaded screw?—That is stronger by some 20 per cent. at least, and it is two inches longer in the bearing; the two put together make a great difference in the strength; they nearly double it.

2541. (*Col. Simmons.*) Is the breech-loading apparatus in the 20-pounder and the 40-pounder the same as in the 12-pounder, excepting that the dimensions are increased?—Very nearly; it is only a difference in proportion.

2542. (*Col. Taylor.*) You have had a great number of guns at different times sent back for repairs; have you had any sent back that have been rendered unserviceable by the fracture of the vent pieces?—I do not remember any instance of that.

2543. (*Chairman.*) Or of the breech screw?—The breech screw has been often damaged a little.

2544. (*Col. Taylor.*) Has that damaged the gun?—I do not remember that it has.

2545. Taking a commercial view of the whole matter, supposing you could get 1,000 rounds at a certain price, you would not care in what way your money was expended in getting those rounds if you could put a certain price upon every round?—Just so.

2546. Supposing that you get with 1,000 rounds from one gun a very much larger per cent. of accu-

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racy and of destructive effect than you do with 1,000 rounds from another gun put in comparison with it, do not you think that, supposing the cost of the two was the same, the balance should be on the side of the gun that produced the greatest effect?—I am of that opinion, certainly.

2547. Supposing you took the average life of a vent-piece from the records of practice throughout the world, and ascertained what the average life of a vent-piece is in rounds, if you took that and the cost of the vent-piece and set it against the number of rounds which that vent-piece will stand, and put the price of that vent-piece over those rounds, you would then ascertain, would you not, what the increased expense incidental to the uncertainty of that vent-piece would be?—Yes.

2548. That would be a fair calculation, would it not?—Yes, quite so.

2549. Then admitting the fact of the uncertainty of the vent piece in the present state of manufacture, would it be an unreasonable view to take of it (admitting the accuracy of the gun, and admitting the destructive effect of its projectile,) to say that for every thousand rounds that you send out with the gun to a fortress you send out in lieu of a given number of shot, taking the transport into consideration, a given number of vent-pieces to make those thousand rounds; it would not signify to the public whether their money was expended in shot or in vent-pieces, provided that the aggregate of the results was in favour of the gun?—So far as I see it would not make any difference.

2550. (Col. Ormsby.) Have you ever seen a gun so disabled by the breaking of the vent-piece that it could not be repaired at the station where the gun was, and it was obliged to be sent to the arsenal for repair?—I cannot say that I have seen much of that.

2551. At any of the out stations where guns have been issued, and are in service, when any gun has been injured by the breaking of the vent-piece, and the gun could not be repaired at the station, it has to be sent back to you for repair?—I do not remember a case of that kind where a gun had to come back for a little thing of that sort.

2552. (Col. Simmons.) Do not you think that the complicated nature of the stores connected with the breech-loading apparatus, and which are necessary to be sent out to the out stations, a great objection to a gun of that sort as compared with a muzzle-loader seeing that so many different articles must be brought on charge by the storekeeper to be always ready for issue when wanted. Does not that make it a more objectionable principle than a simple muzzle-loader, which has no articles of store at all to be issued, because the stores for the breech-loader may not be always present at the moment when they are required?—That is a very important question certainly. In the larger guns the tools become most formidable things to be carried about. Any of the boring out, and the screwing, and the putting in, must be done with as great accuracy as it can be done with the best turning lathe, and hence the instrument itself must be perfect. The spindle, and all the cutting blocks, and the other bearing blocks which are sent out are all got up with the same truth as the parts of the spindle of a lathe; if that were not so there would be no truth in the working; it would not do just to bore a hole, all the surfaces must be perfectly true with each other; then, after those hoops are screwed in they have to be bored out with equal truth, and to be set out as they do for the screw, it is not a fit good enough for a gun, it is a fit that would be soon blown out if something more were not done to it. In the workshop we use a mandrel which is carefully guided in straight, and we use a great monkey of about 3 cwt. or 4 cwt. behind to give it blows to drive it in and make it a tolerably good joint; but on service you cannot carry things weighing  $4\frac{1}{2}$  cwt. in addition to all the other things. They now set it out with gunpowder, and that does away

with the monkey and those great blows and saves  $4\frac{1}{2}$  cwt.

2553. The necessary instruments are required to be so perfect that it would be difficult, would it not, if some of them were lost, to replace them in the field?—Yes; any one who knows about doing work accurately will see that this work must be accurate, must be to the thousandth part of an inch perfectly true to the screw of the gun in every way, and therefore the instruments must be right without any error at all.

2554. In fact it would be impossible to replace the instruments in the field if they were lost?—Yes. They must be able to obtain other instruments as good as those they have lost before they can make a really good sound job of it. There can be no make-shift with a thing of this kind, it must be done really right.

2555. And those instruments are of various patterns and numerous, are they not?—Yes; I have the drawings of them here (*producing some drawings and explaining the same*), these must all accompany the gun.

2556. Could you put in a list of the instruments which you consider necessary to accompany a gun?—Yes, I will do so. This is a lithograph (*producing the same*) of the things that are wanted, and this accompanies the gun. You require separate instruments for every nature of gun, and also separate sighting instruments for every description of each gun.

2557. (Col. Taylor.) Could you state in round numbers what the weight of the whole apparatus going with a battery of 12-pounders is?—I could not say from memory. I would suggest that, instead of sending those sighting instruments with the guns, and spare sights to introduce into the gun when the existing ones are broken, it would be better just to sight the gun on both sides perfect, and allow the gun to take its chance, without having anything extra to carry, because it is not very likely that both sights of a gun would get broken.

2558. (Col. Simmons.) Will the facility of repair to the breech-loading apparatus be increased or otherwise by the new wedge principle?—I think if you consider that matter very closely it is not nearly so handy to keep right as the screw system; you have great latitude with the screw system in going backward or forward a quarter of an inch, but with the other system it must be positively right. If you consider that those wedges are to fit in and come up exactly to their places, the surface must be a definite distance from the front to the back, and we all know how very difficult it is to keep surfaces correct, and when those surfaces want to have something put on to them then we have not the convenience and the facility for doing it that we have with the screw arrangement. It would be necessary to bore the end of the gun out and introduce a new screw, and fit it up with the original accuracy of the gun, so as to make the wedges right. You might get a little on the wedges, but there is very little room for the wedges to go out, more or less, nothing like the facility with the screws.

2559. Do you mean to convey to the Committee the idea that if the breech were solid you would have to bore it out in the rear?—You must keep it up. If it were possible to screw the inner lining of the gun a little back, that would answer the purpose, but that is an impossibility. In whatever way it is done, we must keep that surface up to its original position with respect to the wedge, unless we enlarge the wedge.

2560. Have they not done away with the copper ring bouching in the bore?—I am not sure how that is. That difficulty has yet to be grappled with.

2561. Do you anticipate that the bore will wear away and require bouching?—It is impossible for that ring to be rubbing backwards and forwards without wearing. The chances are that a little gas will pass the cup, and we know that when that is the case



it will soon get guttered into. The instant there is a little avenue outwards established, the gas will soon make a way for itself, and hence the instruments which are required for making good that end of the wedge gun are much more formidable things than the instruments required for the other guns. I have been trying to get out a simple set of instruments for the wedge gun, but there is no screwing arrangement. It must be a very nice tool to introduce to keep up the surfaces correct.

2562. The instrument required to effect the repair would be so complicated that you consider it to be impossible to introduce it in the field?—To any one who is accustomed to it, it is not very complicated, but to the generality of military men it is. Still the gun must be kept good, and it will not be kept good without having some means of taking out one ring and putting another ring in.

2563. The surfaces of the wedges are liable to wear out, are they not?—Yes. I have not yet referred to that; it is another point altogether. If the gas gets upon them no doubt it will score them.

2564. And the repair of them would also have to be provided for?—Yes; those are all difficulties which a few years will bring forward prominently, though they are not now prominent.

2565. (*Col. Taylor.*) Where do you anticipate this weakness; is it in the rear of the wedge?—I will explain it from a drawing. Take the 70-pounder wedge gun. This is the gun itself (*producing a drawing*). What I say is this, that the part which we shall first find wrong will be the gas getting past the cup and getting out in this direction, and we shall be sure to have ruts here (*pointing to the drawing*), and it will be necessary to bore them out and screw a piece in as well as it can be done, and then bring the surface up to where this is; that is, supposing the wedges have not become smaller or altered their dimensions. You cannot expect to do this without proper tools; you must have something to press from and push from and make screws from, and all the instruments which we use for this purpose must be very heavy to carry, and it is becoming a formidable tool to do all that right.

2566. (*Col. Simmons.*) This aperture (*pointing to the drawing*) does not exist in the gun, does it?—Yes, it does; we load at it.

2567. (*Mr. Pole.*) Does not the tin cup prevent in a great measure the escape of gas?—Yes, it does; still, for all that, the gas sometimes gets past. The steel cup that Krup uses is about as good a plan as anything I have seen to prevent the gas passing.

2568. Was not an experiment tried with paper to show that the gas does not get past?—Yes; but that is only one experiment. It is only after a good while that things get wrong. Every one must allow that this must be perfect to begin with, and then when it is perfect, any gas getting past will render it imperfect. If we had a good cup, and could prevent the gas getting past, it would remain a long time perfect; but if the gas does get past we must make it good in some other way afterwards by boring it out and putting another piece in.

2569. (*Colonel Simmons.*) Is not the vent piece of the wedge gun considerably thinner than the vent piece of the ordinary gun?—Yes, it is; but it has a different office.

2570. If there is a wear between the surfaces of the wedges which support the vent piece, it would be natural that on the explosion of the gun it would recoil back against those wedges?—Yes; but the wedges are all well up—there are two wedges.

2571. If there is a wear there and they do not key up exactly to that extent, these wedges just come opposite each other?—Yes.

2572. Is that likely to happen?—It is in the event of the surfaces wearing. If there was any slackness such as you refer to that would take place, but it would have to be prevented, and that is why you would require instruments to keep those guns up.

2573. If this surface again wears, that vent piece

would be jammed up by the wedges, would it not?—But there would be a jamming up in some other part in the vicinity, but the gutters would remain. This gun must be kept up, there is no doubt about that, and instruments will be required to follow this gun to keep it up.

2574. Have any of these guns been fired with a great number of rounds to ascertain what the wear and tear would be?—I am informed by Captain Dyer that 57 rounds was the largest number of rounds that the wedge guns have ever been fired on a stretch.

2575. Have many of these wedge guns been built?—A great many have been built, but they are left in such a state that they can be made either a screw gun, or a muzzle-loading gun, or a wedge gun; the block is ready out of which either can be constructed, but this hole is not yet made.

2576. Have many of them been completed?—A number have been finished at Elswick.

2577. Have they finished any and sent them to Woolwich for acceptance?—They have not begun to come to Woolwich at present.

2578. (*Major Young.*) They have not been finally approved of yet?—No; there has been some misunderstanding about them.

2579. (*Col. Ormsby.*) Have you finished any at Woolwich?—I have finished one or two merely to try them.

2580. To what extent have the trials gone?—At Woolwich there has been no severe trial to test the gun; we can fire them very quickly.

2581. (*Col. Simmons.*) Have you fired them with the proof charge?—Yes they have been fired with the proof charge, the double service charge.

2582. Do you see any signs of weakness in the breech-loading part?—No, nothing particular, but there has been nothing done to call forth the powers of the gun.

2583. (*Mr. Pole.*) With regard to the shunt gun; have you made many of them?—I have rifled a few but they were merely experimental.

2584. What is your opinion of that plan as a means of rifling a muzzle-loading gun?—I have always strongly advised Sir William Armstrong against it; it is a very good plan, but it involves a great deal of trouble, and there is a good deal of prejudice against it, and I do not think it is worth the trouble. I do not know whether Colonel Taylor remembers the shunt gun without the shunting that was sent down, it was just the shunting gun with the shunting not put to it. I said that I felt sure that we would get the same shooting in every way without it; and there was one gun sent down and the report that came up was that it did shoot better than any gun that they had tried. That was put down to the circumstance that I had made the shot myself, and had made them very carefully, which I daresay was in their favour. That gun is in the arsenal still.

2585. Does the objection to it refer only to the manufacture, to its being a little more troublesome to make?—That has a little to do with it; I do not think there is any chance of the shot catching on the shunt side when it comes out although there is a great notion that it will sometimes come out wrong. For my own part I would not recommend the shunt; I would recommend something more simple. We must get very simple things to give satisfaction to everybody, and something that will never be wrong at all. I never say that a thing is right if it is wrong in any respect.

2586. What can get wrong in a shunt muzzle-loading gun; can anything about the shot get wrong?—Not in coming out if you have sufficient windage.

2587. The object, as I understand, is to apply to a muzzle-loader the principle of a soft yielding metal which shall give way as the shot comes out, and guide it perfectly straight without play; is not that object accomplished in the shunt-loading gun?—Yes it is.

2588. Is it accomplished at the expense of any corresponding disadvantage?—It is a more compli-

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cated piece of mechanism in its construction; that is all.

2589. But by rifling machinery it can be done, can it not?—Yes; it can be done of course and therefore no value need be attached to that objection.

2590. Taking the gun as made is there any disadvantage in its working, is not it a very simple affair of the shot going in and coming out?—Yes; but still it is complicated to some extent. I do not think that the great body of those who will have to use it will have the same confidence in it as they would in a simpler thing.

2591. Is there anything wrong in the accuracy of gun?—No, not at all; but there it is with all those grooves and offsets and that sort of thing, and I am of opinion that the army and navy will prefer a more simple gun than that.

2592. (Col. Simmons.) Do you anticipate any wearing in these guns?—No; it will always hold on to the driving side.

2593. (Major Young.) Do you think there is a defect in the projectile?—The shot has to do a little work when it has got to a very high velocity, and if everything is right previously it will be right then; but if there is an extra pinch it will have to go through with a terrible force if it has to pinch as it goes through the metal; causing an enormous deal of work to be done at that instant.

2594. And it must be a soft metal?—Yes; and if the copper has to squeeze through a narrow gorge

like that which you see in the drawing it must be very quick.

2595. (Col. Simmons.) In fact, the objection you take is somewhat similar to that which you took just now with regard to the Lancaster gun—that it is equivalent to an accelerated twist as to its effect upon the gun?—Something of that sort; but it does not tear the gun so much as the Lancaster principle.

2596. (Col. Taylor.) Do you think there is any other method of rifling from the muzzle by which you obtain the same identity of two axes, the axis of the shot and the axis of the gun itself?—I think that any incline will cause it to twist to a centre if there is an incline at all,—such as in Commander Scott's or in Mr. Lionel Thomas's, or in Mr. Whitworth's plan, or almost any of them now; they are all going in for making the thing take the centre. That is easily done, and if the thing takes the centre you get all you wish for. I wish to correct something I may have said about the Lancaster gun; that increasing twist is not essential to his plan; it might be uniform, of course, and then it would not be liable to the objection that was referred to, namely, the gun splitting.

2597. (Col. Simmons.) The Lancaster system does not depend upon the accelerated twist; it is merely the form of the bore?—Just so.

2598. (Col. Taylor.) The manufacture of the Lancaster shells appeared to be very rude, did it not?—They were turned very carefully in a lathe, but they were not polished; the tool just passed over them rapidly, but they were all turned true in a lathe.

The witness withdrew.

For conclusion of Mr. Anderson's evidence, see page 111.

Adjourned to Monday next at 12 o'clock.

Monday, 23rd February 1863.

PRESENT :

MAJOR-GENERAL RUMLEY, Inspector General  
of Infantry.  
COLONEL ORMSBY, R.A.  
COLONEL TAYLOR, R.A., Commander of the  
School of Gunnery.

CAPTAIN PREEDY, C.B., R.N.  
COLONEL SIMMONS, C.B., R.E.  
COMMANDER SINGER, R.N.  
MAJOR YOUNG, R.A., Director of Artillery  
Studies.

CAPTAIN DYER, R.A., Assistant Inspector of Artillery, Secretary.

MAJOR-GENERAL RANDAL RUMLEY IN THE CHAIR.

Colonel WILLIAM B. GARDNER, R.A., examined.

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2599. (Chairman.) What appointment do you hold at Shoeburyness?—That of Chief Instructor.

2600. (Col. Ormsby.) Have you had much practice with both the Armstrong and Whitworth guns?—Not with the Whitworth guns. I have seen some practice with the Whitworth, but with the Armstrong guns I think I have fired about 550 or 600 rounds.

2601. From the different sorts of calibres?—Not from the smaller calibres, not with the 6-pounder or with the 9-pounder, but with the 12-, 20-, 40-, and 110-pounders.

2602. Taking the 12-pounder Armstrong as a field gun, would you give us your opinion as to its accuracy, its range, and its general working; and first as to range?—It has a very good range indeed.

2603. Then as to its accuracy, what is your opinion?—It is of remarkable accuracy.

2604. And what has been your experience as to its working?—The smaller calibres work very easily.

2605. Which do you think work the more easily, the breech-loaders or the muzzle-loaders?—The muzzle-loaders, decidedly; but that is a very complicated question, and it requires to be divided into two distinct parts, because each system has its function. In the field the muzzle-loader, there cannot be a doubt, is the better weapon, but under

proper cover and in casemates, and perhaps on board ship (though I do not feel competent to say much with regard to the navy), the breech-loader might be the more useful of the two.

2606. Which do you consider is the gun best adapted for very rapid firing, the muzzle-loader or the breech-loader?—The muzzle-loader.

2607. Do you think that in its capacity for firing different kinds of projectiles, the Armstrong gun is a very good gun?—Very good indeed. I think that the molten iron is quite a special projectile.

2608. Do you think that the Armstrong gun is adapted for firing molten iron?—So far as my experience goes, I think not; but my experience has not been great. I have not seen more than eight or ten rounds fired with molten iron.

2609. Do you think that the 12-pounder Armstrong field gun is a good gun for very rough work, and for standing rough usage in the field?—That is not my opinion.

2610. Is it a good gun as to its endurance?—Yes; I think that with quiet work it is a very good gun.

2611. What is your opinion about the construction of the 12-pounder gun as a field gun?—The fact is, that for a field gun I do not like the breech-loading principle; it appears to me superfluous and unneces-



sary in a field gun. You can obtain, I believe, as good practical results with a muzzle-loader, and, of course, without the complication and intricacy of the breech arrangement.

2612. With regard to the larger descriptions of guns, the 110-pounder, for instance, do you like that as a breech-loader?—No, I do not; I think that the larger the calibre the greater the difficulties of working the breech arrangements become.

2613. Have you used the side loading arrangement at all?—No, I have not at all. It has not come to us as a service gun; it is still experimental; but so far as I have seen of it, it would be very much more easily worked than the breech-loader.

2614. For coast defences do you approve of the 110-pounder Armstrong gun?—No; I should be very sorry to be working a 110-pounder in case of being attacked by iron-clad ships armed with heavy muzzle-loaders. I do not think that breech-loaders would do, judging from what I have seen at Shoeburyness.

2615. Have you fired any of the Armstrong muzzle-loaders of large calibre?—No, none; I have seen them fired; but that also is not a service gun. I have nothing to do with experiments; I only take the guns as they are delivered to us for service.

2616. (*Major Young.*) Do you think that there is any want of a common shell with the present field ordnance?—A very great want indeed, in my opinion.

2617. Would you recommend that a howitzer should be introduced?—I should be very glad indeed to see one. I think that Colonel Taylor suggested something of that kind when the expedition was sent to America in 1860; and I quite agree with him.

2618. Do you think that the howitzers should be in distinct batteries or attached to the present 12-pounder guns, as in the old field batteries?—I am rather inclined to keep them distinct, so far as my own views go.

2619. What is your opinion with respect to the present time and concussion fuses as applicable to the field service?—We have just changed the pattern, if you mean the new brass one; the fact is this, that the time fuse requires for its perfect working 10 different actions; that is quite irrespective of fixing the fuse and setting it. It is a great question in my mind, judging from what I have read of the China campaign, and from what I see at practice, and from what I know takes place in the stores, whether all those functions would act together to ensure the bursting charge igniting. First of all, these wings, as they are called, must go; this chlorate of potass, or whatever it is, must act, and that depends upon the needle; that taking place correctly, you have this to act, and then you have this communication to act; and supposing that this fuse composition burns evenly, then you have this communication round here to act (*pointing to the different parts of the fuse*). That is quite irrespective of the setting of the fuse, and judging from Major Hay's Report after the China campaign, it appears to me that this is a very difficult and a very uncertain thing. If the Committee will permit me, I will read an extract from it, although you have the whole report. He says, with regard to the time fuses, "I found that in action under fire it is very difficult to get the men to fix them carefully." That relates to this part (*pointing to the fuse*). This has to be unscrewed, and then this is to be fixed, and then this screws up again; and Major Hay's opinion was that those two operations were not easy to perform under fire, and, so far as I have seen from practice, I quite agree with him.

2620. You mean that there is a liability to leave the cap unscrewed?—Yes; there is a liability to leave the cap unscrewed. Then I do not say anything about the construction of the fuse, because that, I believe, is now under consideration; but, so far as I myself am concerned, I have a particular dislike to india-rubber entering into any combination of this kind. I should also like to add, with regard to this

particular fuse, that I have never fired one in my life, because hitherto we have been using up the pattern which has just been condemned; but the principle of adjustment in the old pattern is precisely the same as in this.

2621. Do you consider that the number of tools for repair that are necessary to be carried with a field battery are objectionable?—Yes; I should make that as simple as possible. The more tools you can do away with the better.

2622. And with the present 12-pounder Armstrong guns you necessarily carry with you a large number of tools for repairs?—I believe that is the case.

2623. And the gun cannot be kept in good working order for any very long time without making use of those tools?—I apprehend not, certainly, or they would not have been issued.

2624. Have you made any practice with the Whitworth 12-pounder gun?—I have only seen it fired occasionally. It has never come under my charge in any way.

2625. Do you see any objection to the fact of iron working against iron in the gun?—I did see a very great objection to it, but Colonel Boxer, who has experimented upon that more than I have done, assures me that the side of the groove, which I should suppose would have suffered, does not, that there is more wear on the other side, where the bullet is free, than there is on the bearing side, where the friction takes place; but I do not know of that personally. I only know of it second-hand from him.

2626. Do you like shot coated with lead for rifle purposes better than hard surfaces?—I would rather have a hard surface. If it is possible, the simpler you can make it, the better I believe it to be.

2627. Do you think that lead-coated shot are liable to become injured by service and by store and lying on the works?—I cannot say of my own experience, but I was told the other day that a report had come from Canada that some of the Armstrong projectiles had suffered very much during the summer drill in the boxes.

2628. (*Commander Singer.*) Do you consider the range and accuracy of the Armstrong gun everything that can be desired?—Very good indeed.

2629. Does that apply to every description of gun?—So far as I know, it does. I think that the 110-pounder is not quite so good as the 40-pounder, that the precision is not so great. That was my experience some short time ago in firing it.

2630. Have you fired at all with the 20-pounder naval gun?—No, not at all.

2631. Is the 20-pounder land service gun a good gun with respect to range and accuracy, and equal to the 40-pounder?—I do not think it is.

2632. But do you consider it quite equal to the 110-pounder?—Yes.

2633. You stated, did you not, that the working of the 12-pounder is everything that could be desired, but that with the heavier description of guns the difficulty increases?—Yes; I may say that the difficulty increases with the calibre.

2634. Do you consider that the difficulty is objectionable in a 40-pounder?—I do not think it is. The gun can be very readily worked provided always that you keep your breech screw well oiled. I had occasion to observe that on Thursday. We were firing not very rapidly, and in the afternoon the breech screws worked very heavily indeed, and then I said, "Where is your oil can?" and the oil was brought up and used and then the guns worked well again. I think that at that time there must have been fired about 30 rounds perhaps.

2635. Was that with the new pattern 40-pounder?—One new and one old one.

2636. Did you find any difficulty in the working?—No; the vent piece is laid on the top after taking it out, which simplifies it, and does not make so much weight to lift.

2637. Where do you find the great difficulty in working the 110-pounder?—The great difficulty con-

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sists in turning the levers of the breech screw and lifting the vent piece; and in putting the shot in the gun requires to be slightly depressed before the shot can go properly home.

2638. What elevation do you consider it necessary to depress the gun?—Half a degree. The great thing appears to be to give an incline in the direction of the shot going in. In point of fact, there is no rule upon the subject. The order is simply that the gun is to be slightly depressed. If the shot is driven up hill it becomes very hard work upon the men who do it. I should like to add, with regard to the working of the 110-pounder, that we use a tin cup to close the bottom of the bore, and that adds to the complication of the drill.

2639. Have you ever found, or often found, the vent piece jam with the tin cup after a time?—That has never occurred to me.\*

2640. With respect to the 110-pounder, have you seen many vent pieces broken?—I have actually seen three broken myself, and immediately after firing I have seen a great many more. I have seen vent pieces brought in broken.†

2641. Do you know what material they were made of?—Some were marked "Taylor's steel," and some were marked "Cammell." I think they were mostly Taylor's steel.

2642. Have you ever seen wrought iron vent pieces go?—Yes, I think I have.

2643. With respect to firing molten iron, I think you stated that the Armstrong gun was not successful. In what way did it exhibit any defect in firing?—On the occasion of which I speak there were two vent pieces broken. That was the first thing which struck me; and then the second was, that some of the lead (I was not present at the experiment) became detached and fused.

2644. Did you attribute the breaking of the vent pieces to the greater weight of the projectile?—Yes, I did; but I think that the officer who conducted the experiment would be able to tell you more precisely about it than I could.

2645. You state that you do not consider that the 12-pounder field gun is likely to stand the rough usage of the service. In what particular do you think it would fail?—I judge from what I have observed myself with regard to the care which we must take of it, even down at Shoeburyness, under very quiet circumstances; and then again from the report of Major Hay and the officers who were in China; I thought, as far as regards their opinion, that it was very much against the gun. For instance, one officer, Colonel Barry, says, "On the morning of the 22nd of August, after having bivouacked at Tangu in the rain, the breech screws were nearly completely jammed with rust, and if we had had to renew hostilities at daylight that morning, the gunners, who were already over-fatigued, would have been severely taxed in getting the guns in working order." My own opinion from that sentence would have been to condemn the guns directly without anything else, because if, under such circumstances, an officer writes that his battery is not fit for action, to my mind, at least, it is quite enough to condemn the whole thing. Then, again, he goes on to say, "Whilst in action on the 21st the vent piece of one of the guns of a detached division was blown out. The officer in command states positively that the breech screw was screwed up, but I can see no other way in which it would have occurred than by the No. 2 in the heat of action having failed to do so effectually. I can suggest no means of preventing the same thing occurring again, particularly at short ranges, where rapid firing is required." It is at short ranges, where rapid firing is required, that this thing will happen,

and therefore at the very crisis, so to speak, when you want everything perfect, your gun may fail you. Then Major Hay, in like manner, says, "On two occasions vent pieces were blown away. On the last occasion I happened to come up to the gun almost immediately after it happened, and was assured by every man at the gun, including the officer, that it had been properly screwed up, the man having been seen to do it. The gun was under a heavy cross fire from the enemy's guns. The vent piece becomes so hot that it is difficult for a man to hold it. Under present circumstances I see no reason why vent pieces may not be continually blown out, when the results may be very different, and the gun disabled." The present vent piece is strengthened behind under the idea that it will not blow out, but I should be very sorry, from what I know of the gun, to say that it will not blow out. On the contrary, I firmly believe that if ever the guns are under a heavy fire that will happen.

2646. You think that the projection in the rear face of the vent piece is not a security against being blown out?—I do not.

2647. You have never seen an experiment tried to ascertain that, have you?—No, I have not. The difficulty in this case is, that in action when the breech screw is fouled, which it would be, the breech screw does not go home by a good deal.

2648. Supposing the two guns, the breech-loader and the muzzle-loader, were capsized in a ditch full of mud and water, which gun do you think would be got ready for action soonest; have you ever seen an experiment of that kind tried?—No, I never have.

2649. What is your opinion of it?—If it is simply water and mud I do not suppose it would make much difference; the mud would lubricate the breech screw if it wanted it; but if it is sand, or anything that is dry, it would be very hard upon the breech screw. There is just this difference, that in the one case the gun would be lubricated to a certain extent, and in the other case it would be seriously injured. One reason why, in answer to a question from Colonel Ormsby, I stated that I did not like the gun unless it were well covered was this, that in firing at an earth-work which we made last year, I observed that many of our shot and shell struck the parapet, and knocked off a quantity of dust each time they struck, and that a portion of that dust was deposited upon the unserviceable guns and carriages in the embrasures. Now had those guns been Armstrong guns, they would have been rendered unserviceable for a time. I do not see how it would have been possible within a given time, say five or ten minutes, by any degree of oiling, to have cleared those breech screws sufficiently to have enabled them to have replied to that fire.

2650. Is the thread of the breech screw at all exposed when you are working the Armstrong guns?—In running out, in relieving the vent piece, it is a little exposed, and then in screwing it up again it is a little exposed in front; so that in the case I speak of you would have had the dust either behind or in front of the spot, as the case may have been. I know that I remarked it, and I believe that others did so at the same time, and thought that under those special circumstances, the dust being knocked off the parapet, it would have gone very hard with guns of that construction.

2651. With regard to projectiles, do you consider the segment shell a very formidable weapon in the field?—Yes, very much so indeed.

2652. Taking the Armstrong projectiles in a mass, do you consider them well adapted for the purposes for which they are intended?—I think so, certainly. I should say that the defect now was that the field gun does not contain a bursting charge sufficient to make it formidable as a shell, except as against the personnel; but the effects on targets are very wonderful indeed.

2653. For what reason do you object to india-rubber in the time fuses?—The officers who were in

\* Since giving my evidence I have seen a vent piece jam three times.

† Since then the officers and non-commissioned officers of the long course have broken five more.



India told me that they observed, and in fact I have seen it myself at Shoeburyness, that the india rubber at times adheres to the composition, and at other times in unscrewing them, the india-rubber is ruffled up; and in that case I apprehend either that the composition would be deteriorated, or that you would not have got this part of the fuse (*pointing to the same*) to shut closely over the composition.

2654. Have you had much practice with the new concussion fuses?—We have fired them, and they act very well.

2655. Have you ever tried them in water to see whether they would stand that?—No, I never have; that would hardly come under me; that would be more experimental.

2656. With respect to the Armstrong sights, do you consider them everything that could be desired?—Not at all. I think that sights of that kind are admirably adapted for certain special purposes, but for ordinary purposes I should have the simplest possible sight. I should like to read what Major Hay has stated with reference to that: "I observed the "Nos. I paid very little attention to the vernier on "the scales, and resorted chiefly to guess work for "adjusting their elevation and deflection; this is "not to be wondered at under fire, when even at "drill they experience difficulty in working out the "corrections." Now we have unfortunately adopted a most complicated system of scale altogether, in fact so much so that I may tell you that an officer, now an instructor, and a very smart officer too, at practice made such a mistake as this. He gave the minutes correctly on the vernier and left out the degrees, and this is a kind of thing which, if it had not been stopped, would have occurred more than once. In looking at the scale, there are first the degree and then the minutes, and the degree is divided into sixths; then there is the vernier divided into single minutes on the top, and then there is your deflection scale. Now, between all these a man who is not very well drilled and not very cool, if he is at all hurried, is led astray now and then, and that is why I would have the simplest possible sight; I would leave the very accurate scale for the special purposes which I have referred to, and there is not the least doubt that under certain circumstances the special vernier would be most useful.

2657. You consider that the verniers are very good, but that there does not exist any necessity for using them in the field?—Just so; but if you did not use them you would be led astray by them, because they ought to be at zero.

2658. (*Chairman.*) What is the field complement of vent pieces with each gun?—There are two at present.

2659. Have you seen many accidents with the vent pieces during practice?—I think I have seen about eighteen accidents altogether.

2660. Has that been with the present pattern, or with the old pattern?—With all patterns.

2661. Have you seen some accidents even with the latest pattern?—Yes; I do not keep a record of them, and I cannot tell exactly how many, but Colonel Taylor could tell exactly.

2662. What is the nature of the accident?—The vent piece splitting.

2663. What was the result?—We had to change the vent pieces.

2664. Were any persons injured?—No; I never saw anybody injured by the splitting of the vent pieces.

2665. (*Col. Simmons.*) Have you any difficulty in training men to the use of the Armstrong gun?—As far as regards firing simply, I think that they learn the drill, especially of the smaller natures, very easily indeed, but there is a difficulty about the 110-pounder, they do not pick it up very quickly.

2666. With regard to training the men and teaching your artificers in the batteries to repair the guns, do you find any difficulty?—I do not know; I have nothing to do with that.

2667. You stated that the repairs to the guns necessitated the carrying of a number of complicated tools; do you consider that the repairs with those tools are such as can be readily done by gunners and such men as you have in the service?—The artificers are all trained; you could not trust the gunners to do it.

2668. You spoke of a report from Canada of injury to the Armstrong shot; can you tell the Committee by whom that report was made; is it a public document?—No, it is a private report.

2669. Is it an official document, so that it could be obtained?—I have no doubt that Colonel Bingham could give it the Committee; in fact my friend when he sent to me told me that accompanying it an official report was going home, therefore his Royal Highness the Commander-in-Chief has it.

2670. You also spoke of a difficulty having occurred with a 40-pounder in working the breech screw after 30 rounds. Have you found the same difficulty with the lighter description of gun?—I think as a general rule they all require oiling.

2671. So that with a field gun, if you had not your oil can with you, you would find a difficulty in working it?—You always carry your oil can alongside.

2672. If the supply of oil was lost in the field that might create difficulties, might it not?—I should be sorry to have such a thing happen.

2673. You spoke also of Major Hay's report to the effect that after the guns had been exposed the breech screws had become rusty so that the guns could not be worked with facility. Have you tried any experiments at Shoeburyness or at Woolwich by leaving the guns out in the open air for a night, or in the rain, in order to see what the effect would be?—I think the Select Committee tried it at Woolwich.

2674. Did the guns work well after the exposure?—Yes, they worked perfectly well I have heard; but General St. George could give more particulars about that.

2675. You spoke also of the screws being choked by the dust knocked off the parapet; did you try to load the guns immediately afterwards?—They were obsolete unserviceable guns put there just to be fired at, with the object of dismounting them if possible.

2676. You did not try them?—No, we could not; they were the old cast iron guns. What I said was this, that had such an accident happened to an Armstrong gun I have not the least doubt that the gun would have been rendered unworkable for five or ten minutes. It would be necessary to take it out to clean the breech screw. But anybody can try the experiment in five minutes, by taking a little dust off the road and throwing it on to the breech screw.

2677. On the whole I think the Committee gather from your evidence that your experience of the breech-loading Armstrong gun is that it is so complicated that it is scarcely fit for adoption in the field?—Yes; if I had my own will there would not be another breech-loader in the field to-morrow. There is no necessity for giving your men more work to do than they have to do already.

2678. Have you any knowledge of the Armstrong shunt gun as a muzzle-loader?—I have seen it fired, but I do not know much about it; it is still experimental; it has not come into the service yet.

2679. (*Col. Taylor.*) You state that you object to the principle of breech-loading for field guns, would you state to the Committee in as precise terms as you can what difficulties you impute to the breech-loading system?—I think the difficulties are, that your breech screw is liable to get distorted and damaged, and that it requires lubrication; these are the chief objections. I can conceive a case: if your guns were in the possession of the enemy's cavalry for five minutes they might all be totally disabled, or so disabled as to render them useless for some little time.

2680. Do you think that applies exclusively to the breech-loading rifled gun; do not you think the same would apply to any gun?—Yes, to any gun.

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2681. Then it is not peculiar to the breech-loader ; but with respect to the breech screw sticking which you spoke of requiring oil, have you never tried water as a lubricator instead of oil ?—Yes ; I think water would do.

2682. And probably answer equally well ?—Yes. I say if a gun were put into a ditch full of water and mud, the breech would come out well lubricated, but at the same time, if your gun were left in a very rusty state, I do not know that you could depend much upon water the next morning.

2683. Do you think that an officer in command of a battery in the field would be considered justified by the commanding officer of the artillery if he pleaded as an excuse for having his guns unserviceable when brought into the field in the morning, that he had left them unwatched and neglected during the night ?—That is a question of discipline ; I merely quoted what Captain Barry said.

2684. I want to know whether you consider that the danger attaching to the exposure of the gun is one so beyond the reach of the care of the officers and non-commissioned officers in charge of it as to be a serious objection ?—I could not say as to that.

2685. During the course of the practice that you have carried out at Shoeburyness, how many instances do you think you have had of a gun actually thrown out of action by any accident whatever, I mean of a gun obliged to be stopped and sent away ?—The only case that I know of *personally* happening to me was one in which we broke the traversing saddle, and then we could not keep the gun in the trunnion holes.\*

2686. Have you ever known any other case of the traversing apparatus getting out of order ?—No, I have not.

2687. Taking the case of the rifled gun, speaking generally of rifled guns, do you not consider that there is greater chance of a shot sticking in the rifled gun than there is in the old smooth-bore gun ?—Yes.

2688. Do you think that the extraction of that shot would be an easy operation, or would it not be a serious delay to the gun ?—I suppose you would have to blow it out.

2689. Would you not do that more easily with a breech-loader than with a muzzle-loader ?—I should be very sorry to touch a shell in such a case there ; there have been two instances that I know of where we have attempted to touch a shell that has stuck, and it has exploded.

2690. You mean in drawing it out through from the front ?—Yes.

2691. Do not you think that having the breech-loading system would obviate the possibility of the shot sticking, because you can put your shell in at the breech, and then put the charge behind it and force it through ?—Yes ; I think in that sense having the opening through the breech is very useful.

2692. You know, of course, the construction of the Armstrong gun and the mode of rifling ?—Yes.

2693. Do you not consider that the bursting of a shell with a good large service charge, say 1 lb., the service charge of the 20-pounder shell (1 lb.), would be liable to injure the inner surface of the bore to such an extent as to make it extremely difficult to get the shell home ?—Yes, I have been told that it is so, but a case has never occurred to me to see a shell broken in the bore under any such circumstances ; I can conceive that it would have a very bad effect upon the rifling.

2694. Are you not aware of experiments having been tried of turning over a breech-loader into a ditch and bringing it out full of mud ?—I did not see it, but I remember it being mentioned the other day ; but, as I think I mentioned to General Rumley, it

very much depends upon the state of the mud. If it is simply soft clay and that kind of thing, I do not think it would hurt the gun at all, but, on the other hand, if it was a gravelly bottom or sand with which the gun would come into contact, it would be very injurious.

2695. You stated in your evidence that you thought it advisable to add to the present armament for field purposes a gun capable of carrying a shell with an adequate bursting charge ?—Yes.

2696. What is your opinion with regard to the advisability of being attached to a portion of a battery ?—I consider it very advisable.

2697. Do you not think that it is a great object in the field to avoid the mixing up of the ammunition more than is absolutely necessary, and that there would be no difficulty in detaching from a separate brigade called the shell brigade such guns as might be required by any emergency in the field for a time, those guns returning to their brigade when their duty was completed ?—None whatever. I was only too glad when I heard that you had suggested to Colonel Bingham or his Royal Highness that there should be 20-pounders sent to Canada with a view to meet that case, because having been there and knowing how very short many of the ranges there are, I thought that the Armstrong 12-pounder battery would frequently be very unhappily placed without them.

2698. With respect to the fuses do you not consider it an additional advantage having your shell so arranged by the insertion of the two fuses that it would act either as a time fuse, if the time fuse were correctly fixed, or should the time fuse fail it would act on concussion ?—Yes, I do.

2699. With respect to the value to be attached to accuracy, do you consider that a gun, the accuracy of which may be called 90 per cent. is worth double as much as a gun the accuracy of which is 45 per cent. ?—I do not see how you can make a comparison between two things so totally dissimilar.

2700. Taking a gun, the average accuracy of which is 45 per cent., do you not consider that in paying for or in whatever other way you like to procure a gun the accuracy of which is exactly double, namely, 90 per cent., that more accurate gun is worth more than double the other ?—It is a question of circumstances very much. If your men are hurried in firing, in fact if it is case shot that you are firing, then the accuracy is not of so much importance ; but if it is a question of long range, then the accuracy is invaluable.

2701. It has a moral as well as an actual effect ?—Yes, but in considering a gun you have to take all the circumstances into consideration, short and long ranges, rapid firing and hurried firing. I was very much astonished about two years ago when in the course of instruction we fired the 9-pounder gun and the 24-pounder howitzer very rapidly, dismounting and changing wheels and all that kind of thing at targets about 800 yards off, some in line and some in column, I found that the effect of the smooth-bore guns under all those circumstances was as good, or if I remember rightly it was rather better, than that produced by the Armstrong gun, under similar circumstances ; and I attributed it entirely to this, that the men or the officers were hurried in both cases, and the accurate firing that you would like was possibly a little overlooked in the excitement to get their gun fired first. But if it is a question of long range, then the rifled gun undoubtedly is very superior, in fact there is no comparison.

2702. Do you not conceive that in an army taking up a position the value of a gun or a battery which could concentrate all its fire on the debouching of a column from a wood would be incalculably great ?—Certainly.

2703. If you were called upon to advise for the arming of a sea face for one of our coast batteries, what armament would you select ?—That depends very much upon the depth of the water.

\* Since giving my evidence two 110-pounder breech screws have been so disabled by the splitting of the vent piece, that we have been obliged to send the screws to the artificer's shop to be put in the lathe and refaced.



2704. Take a depth of water that would enable ships to come up within point blank range of forts, such as those now contemplated at Portsmouth harbour?—If armour-plated ships were to come alongside I would rather have the old 68-pounder, but if they could not come alongside then the value of that gun is comparatively little.

2705. Provided that the manufacture could be successfully carried out, you would rather arm a sea face with the largest smooth bores that you could get?—Yes; I think that in the hour of need they would be invaluable, although, if it is a question of range, I cannot say that I have a very great opinion of the smooth bore.

2706. It has been urged by some that the having windage to a gun has the great advantage of enabling you to use the service fuse; have you or have you not seen considerable irregularity with the old wooden service fuse after it has been kept some time?—I can hardly answer that question, for I think our fuses all come to us pretty nearly direct from the arsenal, and they are well stored and well taken care of.

2707. Have you never seen irregularity in firing, even with fuses comparatively new?—I do not think that they always burn very equally.

2708. Could you mention any very recent instance of that sort which has occurred in practising at the earthwork and at the rifle-pits at Shoeburyness?—No, I think not. I have been told of a case, but I was not at the guns at the time.

2709. But you were near the battery, were you not?—Yes.

2710. You saw then a number of shells that passed over into the sea without exploding?—Yes; they were put out on striking the water; they were bored too long. I think they began boring about '5, and I sent up word to them to reduce it, and the last fuses did very well indeed; but we have the record of it. My impression is that after they corrected their length of fuse everything went on very well.

2711. Can you put in a return of that practice if it be required?—Yes, I can do so.

2712. With respect to the failure of the vent-pieces of the heavy guns, speaking of the 110-pounder, do you consider that with the present alteration with the projection at the back, there is any risk of injury to the *personel* of the gun?—No, not so much as there was before.

2713. Have you known an instance of one of those projecting vent pieces of any calibre having yet been blown out?—I think you would know more about that than I do. I suppose the quartermaster could furnish the returns. I do not remember any instance of one being blown out.

2714. You have carried on some practice with the pillar fuse, have you not?—Not a great deal.

2715. Have you seen it?—Yes.

2716. Do you consider it a formidable fuse for the purpose for which it is intended?—I think so, most decidedly.

2717. As being able to stand the concussion ricochet of the water, and at the same time to explode on striking the ship?—Yes.

2718. Do you not consider that the coil mode of construction of a gun has this advantage, that the deterioration of the gun always revealing itself before it becomes absolutely dangerous, there is an element of confidence to the men who use it?—Very much so. I do not know much about it practically, but at the same time I think, so far as I know of the subject, that I should be inclined to prefer a solid gun if it could be made solid; we have seen instances of the coils separating.

2719. But in the gradual process of that deterioration you have a warning of your gun going, instead of its going without any warning at all, as was the case with the old cast-iron gun?—Yes.

2720. And as would be the case with the homogeneous iron gun, unless you could ensure perfection of metal?—Yes.

2721. Do you consider it an advantage or not

having one projectile available for all purposes, and capable of being adapted to all purposes?—Yes, a very great advantage.

2722. (Col. Ormsby.) What description of gun have you seen produce the most smashing effect against iron plates?—I think the 13-inch Horsfall gun.

2723. Was it a smooth-bore or a rifled gun?—A smooth-bore.

2724. Has the Armstrong gun a smashing effect against iron plates?—The gun, i.e., the vent piece generally goes first, so far as my experience goes. I imagine it is very much a question of projectile, so far as I have been able to judge from what I have seen. If the projectile is a good one you get through, but if it is not a good one the projectile itself breaks up; but Captain Dyer would understand that subject better than I do.

2725. You stated that in the case of a gun behind an earthen parapet being fired at, you thought that an Armstrong gun would become unserviceable, at least for a short time, from the sand and dust getting into it; would not that affect a muzzle-loader rifled gun even more than a breech-loader?—I think not.

2726. How long do you think it would take to train men to use the Armstrong gun so as to work it properly,—men just taken from the preliminary drill, not an artilleryman?—Three weeks is the short course.

2727. Can they do it effectively in that time?—They learn it; they learn the small natures very easily, but when you come to the heavy natures the service is comparatively very troublesome.

2728. Do you think that it takes longer to train them to the breech-loading system than to the muzzle-loading system?—Yes, decidedly.

2729. Do you attach very great importance to having a rifled gun as a field gun instead of a smooth-bore?—Major Young would be able to give a better opinion on that point than I can do. I confess I should like a rifled gun, for certain circumstances to which Colonel Taylor has alluded more particularly; but the general impression seems to be, both in America and in Prussia, that in certain proportions smooth-bore guns would be very useful. It is rather a difficult question to answer right off.

2730. If you had the fitting out of a battery yourself for service in the field, how would you arm it?—I should keep the natures quite distinct. I would have one rifle battery by itself, and I would have the smooth-bores by themselves; and I should be inclined to say about half smooth-bores. It appears from the last record of our officers who visited the continent in 1861, that the general feeling in Prussia and elsewhere was that about one-third rifle guns was the proportion. You must have rifled guns as a matter of course; there is no doubt about that.

2731. From what you have seen, which mode of rifling do you consider the best, the Armstrong or the Whitworth?—Really I cannot say; I have had very little experience with the Whitworth. It appears to me to be a wonderfully accurate gun, judging from what I saw at the iron plates last autumn; but I cannot say anything more than that.

2732. Do you think that there would be much risk of the shot sticking in the Whitworth muzzle loader?—I think, if I had anything to do with it, I should like the shot to be cleaned before they are put into the bore. That is my feeling at this moment, but I have had no experience with them, therefore I do not like to give any decided opinion.

2733. If the Boxer fuse could be used with the Armstrong projectile, which would you prefer, the Armstrong fuse or the Boxer fuse?—I would rather have the Boxer fuse.

2734. Why?—I think that in theory the Armstrong fuse is the best by far, but I am not quite sure whether practically it would be so, for the reasons I stated in answer to a former question. One has to consider that perfect accuracy of the sights of a gun and fuse may be obtained at a very great expense, and

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2735. Do you think that it requires a great deal more nerve and coolness in setting the Armstrong fuse than in setting the Boxer fuse?—I judge from what Major Hay says in his letter more than from anything else.

2736. Do not you think that may have occurred from the want of experience in the men, it being a recent invention, and that they were not up to the working of it?—I cannot say indeed. I presume they were drilled.

2737. (*Major Young.*) Do not you think that for a gun of position or for a siege gun, where extreme accuracy might be desirable, that the breech-loading system would be applicable for such a position?—I think, if the gun is covered, it would be a very good system. As a matter of course, a rifled siege gun must be a very valuable thing.

2738. I think also, from what you have said, you are prepared to agree in the opinion that only a portion of the guns for a coast battery should be rifled guns?—Yes, I think so. I confess I did not think so until the armour-plated ships were so common as they are, but now I have changed my opinion very much with regard to the armament.

2739. (*Col. Simmons.*) With respect to the fuse, you suppose the possibility of a screw not being screwed home; what would be the effect of firing the shell without the screw being home?—Then the composition would light and run round at once; it would blow up in fact.

2740. If you were firing a shell with a fuse of this nature over your own men or over another battery, accidents of that sort might produce very serious disasters to your own people?—Yes. My opinion with regard to the fuse was formed partly from what I have seen myself and partly from the opinion of Major Hay, which I have read.

2741. The fact of its being a wrong-handed screw, when men are excited, tends to complicate it, does it not?—Yes. I know when first it was put into my hands I was always screwing it up wrong.

2742. You say that three weeks is the necessary time to instruct a gunner in the drill with the Armstrong field gun, do you consider that men so instructed are fit to take the field in fitting out a battery for active service; would you object to have men only so instructed?—I said this, that our short course of Armstrong drill at Shoeburyness is three weeks, but that does not at all apply to a man's training, that is after he has come to us.

2743. After that training of three weeks you consider that he is fit to go into the field?—Yes, as far as regards the working of the 12-pounder gun.

2744. Have you had any experience of the Armstrong gun as regards penetration into earth?—My own experience has not been very great, but the Committee have on record a very large amount of experience indeed. We fired into a siege work that we had made to destroy, and as far as I could tell (because when the earth is once shaken up it is not very easy to ascertain the penetration) I found

that the penetration of the 40-pounder was about 12 feet at 950 yards, and when the earth became thoroughly shaken the penetration was much more, in fact we cut through the upper part of the parapet altogether; the parapet was about 20 feet thick at the top, and we cut through it, so much so that we displaced some gabions in the top course.

2745. Do you consider the rifled gun preferable to the smooth-bore gun as a breaching gun at short ranges?—Not at short ranges, but at long ranges it is decidedly preferable.

2746. In working up to a fortress, where you naturally could not breach the wall till you had arrived quite close to it, what gun would you recommend for a breaching battery?—I should prefer a rifled gun, because you can throw projectiles over the glacis, as the Prussians did the other day in Prussia; you do not require to see the wall, you can throw your rifled shot to the part where you know the wall exists, so that you could make a breach at very long distances; in fact it will completely alter the attack.

2747. You could throw shot under such circumstances with low charges?—Yes.

2748. Would they have penetration in such a case against masonry?—Yes, about six feet thick the brickwork was penetrated; that was the result of the experiments at Julich. There was a pamphlet published by an officer who was present which gives an account of the whole thing. I cannot at this moment tell the dimensions, though I have drawings of it. The rifled gun would be an immense advantage in large attacks.

2749. Do you think the accuracy of a rifled gun and the facility there is of exploding the built up shell would render it unnecessary to establish enfilading batteries?—I think myself that a direct fire would do a great deal. I do not see at this moment how the enemy's embrasures could stand if it is a question of direct fire; that is supposing your guns are as powerful as your opponent's. The result of our experiments last week in firing the 40-pounder was this; we fired 20 rounds altogether that day, and the embrasure was knocked down and choked up most thoroughly.

2750. Did you fire segment shell?—No, nothing but shot; we could not burst the shell on account of houses and people in the vicinity. The effect of shell would be much greater.

2751. (*Col. Simmons.*) With regard to the effect of the segment shell, in killing the gun detachment and the men behind parapets, do you think it would be very great?—I should think it would be very great; but I should be inclined to say that vertical fire from mortars will always retain its value. We cannot do without it.

2752. I am speaking particularly of the enfilading batteries?—There is no doubt of it, whatever. We were enabled to hit a traverse within a face about 30 feet long. We hit the traverse more than once at a distance of close upon 800 yards, firing over the top. That is very remarkable practice.

2753. (*Col. Taylor.*) What is wanted for that is a more sensitive concussion fuse?—Yes.

The witness withdrew.

Captain HUGH BENT examined.

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2754. (*Chairman.*) What position do you hold?—I am Assistant Superintendent of the Laboratory at Devonport, and in charge.

2755. How long have you been in that position?—I have been in charge since July 1859.

2756. All the ammunition and projectiles that are sent on pass through your hands?—Yes; we have to prepare and pack those for ships in commission, and receive from ships paying off.

2757. Would you describe to the Committee any facts that have presented themselves in the course of those issues?—With regard to the Armstrong am-

munition, we have hardly had time to judge, but one or two facts have been elicited. For instance, I find, with regard to the gas-pipe bursters, that in their manufacture apparently care had not been taken to see that they were properly dry, and the powder in some of them had become very much damaged in consequence of the damp, and the pipe itself had very much corroded. That was one point which I noticed; and in consequence of that I suggested that the gas pipe should have a sort of coating with a preparation to protect it from rust both inside and out. The Select Committee had this report from me, and they



thought proper to consider that there was no occasion for it, and it has not been done; but I noticed that the powder was damaged by this damp right through, and the gas pipe also; and I suppose that in course of time both the one and the other will be rendered unserviceable.

2758. Did you notice any other point?—I noticed with regard to the Armstrong shot and shell the gradual appearing of the lead becoming loose on the different natures, first on those attached with tin, and now on those upon the under-cut system, and I have noticed it on one or two attached with zinc solder, but the deterioration in the latter appears in a different way, more in a sort of blister, in the other cases the lead appears loose, either at the top or at the bottom, and you can rip it right off.

2759. Even with the zincing process you have noticed the same defect?—We have only just begun to observe it; we have hardly had an opportunity yet, but I noticed that five 12-pounder shot were defective and two 110-pounder shot, one of those 110-pounders having been much injured in the transit from Woolwich. In the two 110-pounders and the five 12-pounders, where the zinc process was applied, the fault apparently was owing entirely to defective workmanship, to some carelessness in the manufacture, the men employed not having properly dipped the shot in the zinc bath. We supposed it must have been something of that sort, because some of the parts looked as if they were dirty, and those parts came off. With regard to the percussion fuses, we have this strong objection to them, that we never know whether they are in good or bad order, it is impossible ever to be able to report upon them when they come home from on board ship to say whether they are serviceable or unserviceable. And with regard to pillar fuses, we have noticed that it is very difficult to draw them after they have been in for some time. They have been in the service some year or a year and a half, that is a very short time but in that course of time they become so fixed in the shell that it is very dangerous indeed endeavouring to remove them.

2760. (*Col. Taylor.*) You furnish them fixed, do you not?—Yes, we furnish them fixed, and then they go abroad. For instance the "Doris" came home the other day from the Mediterranean, we endeavoured to draw the 110-pounders, but several resisted, and not only that, instead of the fuse turning the cover began itself to return. I reported this, and the answer that came back was that a little oil ought to have been used, that those were of early manufacture, and that after a time they would disappear from the service, and only those would be issued which would not move, but those that we moved are of the newest manufacture, so far as I can see. It appears to me rather a grave matter, because we may explode the shell in endeavouring to draw the fuses. If the fuses were not fixed, and if they were screwed in immediately before action, that might be avoided, whereas I cannot issue any of those shells again in which the fuses cannot be drawn, I shall have to fire them all away, and I suppose that will occur at every station. There is a very delicate composition, and the least bending of the cover downwards will explode the shell.

2761. You are now speaking of the pillar fuse?—Yes; Sir William Armstrong said that he was perfectly aware that the fuse could be exploded by the blow of a hammer. I said that some of those shells had been sent to me into the Laboratory out of their boxes with the pillar fuses fixed, and I endeavoured to draw the fuses before I issued them over back again to the storkeeper. We have a drop of about 16 feet into the hold of the vessel, and we have to lift the shells out on to a jetty by means of slings, and if one had dropped through the slings into the hold amongst other loose shell the fuse would have exploded, because you can explode the same fuse with a hammer; but it was said that it was quite well enough secured, and safe, and that that could not happen; I have seen fuses

projecting slightly at the fuse hole because of the thread not being properly cleaned, and in that case I think there would be danger.

2762. (*Chairman.*) Does anything else suggest itself to you?—I think, with regard to the gas pipe which I mentioned first, if the gas pipe was lackered on the inside that would be a very great preservative both to the gas pipe and to the powder, and would make those bursters last many more years. I may state that we find that the powder has really deteriorated in the course of time, and in the course of three or four years it would not have sufficient force to burst the shrapnel, and if the fuse was lackered inside with the same sort of coating that you put into the interior coating of the shell, but perhaps with a little more spirits of turpentine it would be a very great preservative.

2763. (*Col. Ormsby.*) How are those bursters packed; are they packed in waterproof cases?—No; they come down in boxes. It was recommended that they should have some sort of composition to prevent the damp from getting in, but it appears to me that it is when the powder is put in at the first that the thing is damp, and this lacquer outside which I propose for making it impervious would not have the effect of curing that, because the damp is there already, and if it is there it cannot get out; whereas if this coating were put on inside it would hardly cost anything, and it would effectually prevent the damp from getting into the powder, and it would preserve the iron.

2764. Have any of the fuses exploded?—We have exploded them, because I wanted to see whether they would do so or not.

2765. Have any exploded accidentally?—No, not as yet, I am happy to say. Those pillar fuses are screwed into the shell, and if they were to explode the shell would go.

2766. (*Col. Taylor.*) Why should they all be screwed into the shell?—The order is that all filled shells are to go with the pillar fuses screwed into them, and now there is an order that all the boat shell are to go with the Pettman fuse screwed in; whereas before we used to send them away with a plug. There is very little adjusting required in putting in the pillar fuse; you have just to screw it in.

2767. (*Col. Ormsby.*) What do you think is the cause of the lead stripping off the shot?—It appears that a sort of rusting has gone on (you can see it as plainly as possible), and that separates it at once. Of course that goes on gradually, and as time goes on you would have the whole thing separated. It has been increasing so rapidly lately that I fancy in the course of time they will all become in that condition.

2768. That renders them unserviceable, does it not?—It renders them loose. I am not able to judge whether it renders them unserviceable, because I have never had any opportunity of firing any of them. I should suppose that they would strip if they were fired.

2769. Do you know that those two 110-pounder and five 12-pounder field shot were of the very newest pattern?—Yes, of the very newest pattern, with lead and antimony.

2770. (*Col. Taylor.*) You state that portions of the metal have given way with the lead?—Yes; we cut away the iron with the lead.

2771. (*Col. Simmons.*) Have any of those shot prepared with the zinc process been out for commission yet to sea?—Some of them have gone, but I do not think that any of them have come home yet. I have not seen any. Those that came home with the "Doris" were all tinned; they were of the very first manufacture at the Gun Factory.

2772. (*Major Young.*) Why is there greater difficulty in extracting the pillar fuse than the old Moorsom fuse?—The Moorsom fuse you unscrew, and it comes out; but in the pillar fuse there is another part which will give way instead. I wrote up about it, and said that if they made the cover with a shoulder in it, or a projection in it, or else if they

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had a turn-screw going right across the top, the same as in the first pattern, that would effectually prevent this. But at present they have made this cut so that the turn-screw goes right into the cover only, whereas if the top were put in with a certain little projection inside, fitting into the ring, in turning it you must turn the whole body of the fuse. I may observe that the old lubricators all came home in a very bad state, but as they are out of the service I need not mention them particularly.

2773. (*Commander Singer.*) You stated that you never could ascertain in what condition the pillar fuse was, even if you got it out of the shell; did I understand you rightly?—Not without destroying the fuse.

2774. The same objection applied to the Moorsom fuse, did it not?—Yes; but I mean that they are sent from the contractor. I cannot tell whether those are in a safe state or whether they are not. For instance, whether they have got collars or whether they have not. Supposing the collar were accidentally left out in the manufacture, it would be an unsafe thing to put into a shell.

2775. Do you ever examine the inside of a percussion fuse?—We examine all the percussion fuses and the Moorsom fuses. When we take them out of the shells we always send them to Woolwich, and they come down to us as a new issue from Woolwich.

2776. You could not tell whether there was a pin out?—Every part of a Moorsom fuse is examined before being put together.

2777. Why do you suppose that the pillar fuses are not examined in like manner?—I understand that they are issued in by contract, and if so it is impossible that each part of the work can be examined before they are put into the fuse. I speak of that for this reason, that in two or three instances it has been found that the metal collar has not been in the fuses, and if that was put into the shell you may be sure some accident would happen. If there was only some mode of inspection before they were issued it would be all very well, but there is no mode of inspection when they are sent in by contract. The Moorsom fuse were always inspected in that way, and there were always a certain number of them proved, but even then after they were taken out of the shell we always sent them back to Woolwich. I do not know what they did with them then, but I suppose there was something done. I fancy you could have taken the Moorsom fuse to pieces more easily than you could the pillar fuse.

2778. The pillar fuse is only solid on the top?—Just so. It is easy to take it to pieces and cut it up.

2779. Has any Armstrong ammunition come to you unserviceable through the lead getting misshaped at the base?—Yes. I find that very much so indeed; but then, of course, by tapping and smoothing it round, we can very often get it back into shape to pass the gauges; but that is one great difficulty that we have, and it gives us an immense deal of trouble. All the shells, after any moving at all, are out of gauge, and we have to do something with them; either they will not pass the high gauge or the low gauge.

2780. (*Major Young.*) Does that observation apply to all shells?—To all Armstrong shells of all natures, more particularly the last lot of 12-pounders that came down. We found that they would not pass the high gauge. The man who came down, the leading lead-man from Woolwich, said that it was entirely owing to the pressure to which they were subjected in coming down. We rendered each shell serviceable, but it took some labour to do it, and we had to file them slightly.

2781. (*Commander Singer.*) Have you ever seen a shell in such a condition that it was rendered unserviceable?—I have seen some very much knocked about in landing, both shot and shell. In every ship there are some dozen shell which are so knocked about and almost rendered unserviceable; for instance, a sharp edge striking the base will sometimes cut well

into the lead up to the iron. We have seen that constantly occurring in the hurry of taking them out.

2782. (*Capt. Preedy.*) Have you examined any ammunition which has been landed from ships returning from tropical climates?—Not Armstrong ammunition. I do not think that we have had a fair time yet for judging of any of that ammunition which has come home from on board ship. Those vessels which have come home had only just received it, I think; so that it could only have been out a very short time.

2783. (*Col. Simmons.*) Have many of those shot been so damaged that you could not reissue any of them after undergoing the ordinary repairs which you are enabled to give them in your department at Plymouth?—I certainly think that some of them have had such very severe handling that they could not be got to gauge, and without passing the gauge I do not know what to do with them. I am not allowed any option.

2784. Could you give the Committee any idea of the proportion of the shot damaged in this way; does it amount to any considerable per-centage?—No, it does not.

2785. Does it amount to one per cent., for instance, or anything of that sort?—I could not say. We find the rings knocked off at the bottom, and I cannot put them on again. I found that in three or four cases.

2786. Including those, does it amount to any appreciable proportion?—From my personal experience I could not mention any per-centage at all; we have had a very short time to judge of anything about them.

2787. Have you found many of the time-fuses which have been issued for service damaged?—I do not think that we have had any that were damaged. We always allow a per-centage, but I do not think that in any of the ammunition we have found anything wrong excepting with those iron bursters.

2788. (*Col. Taylor.*) When you have these fuses returned from ships in commission, are they taken on your store ledger or do you hand them over to head quarters and get fresh from them?—They are taken on the store ledger of our station, and re-issued on the spot if they are serviceable.

2789. Do you ascertain their state by proving a certain number of them?—Yes, by firing a certain per-centage out of so many shells and so many fuses that have come home on board ship. Of course the storekeeper cannot have the whole number back, because some have been expended in proof and some are taken on as repairable, and he would re-issue them back to Her Majesty's ships.

2790. And I suppose there is a communication going on between your department and Woolwich by hoy?—No; we have steamers, and we have some merchants' vessels, private vessels, bringing down gunpowder, but the "Lord Panmure" brings down most of this species of ammunition.

2791. Have you any of the new pattern time fuses with the brass body issued yet?—Yes, I think we have; I do not receive those things; I never know till I am called upon to pack what is in store, except at the quarterly inspection, and between the quarterly inspections a store may have come in. I rather think that Mr. Stapley may have a store of these fuses.

2792. You get the usual deliveries of store, do you not?—The storekeeper does. He writes to me stating that he wants certain things for packing a ship, and then I go to work; but in the mean time he may have had the store for some time before it is required to be packed. I hardly think that he has a store of the new pattern time fuses.

2793. (*Col. Ormsby.*) With regard to the shot and shell that came from on board ship, and which you say were so much damaged by the stripping of the lead, do you think that in case of emergency those shot could have been made serviceable on board ship?—I do not know; it all depends upon whether the shot would not immediately strip and leave the lead behind, and that could only be ascertained by actual



experiment. If I could be allowed to take any number of those loose ones and try them, the thing would be answered at once, but I could not say whether they would be serviceable or unserviceable without firing a few of them. Some of them, I understand, were very loose, so loose that the lead could be stripped off the whole body without any difficulty, and then when the lead had a good hold upon the gun, I should imagine that the iron would leave the lead.

2794. (*Col. Taylor.*) Was that the case with some of the last pattern?—No, not with the zinc; the zinc held uncommonly well, but in one or two places large blisters appeared, and when we cut away those blisters we found that the defect extended some distance, but I imagine that there was some little carelessness before the shot or shell was dipped in the zinc bath; the iron was greasy or something of the kind, and then the zinc did not hold it properly. I cannot account for it in any other way.

2795. Are the shot which blister easily repaired?

The witness withdrew.

Adjourned to to-morrow at Eleven o'clock.

Tuesday, 24th February 1863.

PRESENT :

MAJOR-GENERAL RUMLEY, Inspector-General of Infantry.  
COLONEL ORMSBY, R.A.  
COLONEL TAYLOR, R.A., Commandant School of Gunnery.

CAPTAIN PREEDY, C.B., R.N.  
COLONEL SIMMONS, C.B., R.E.  
CAPTAIN SINGER, R.N.  
MAJOR YOUNG, R.A., Director of Artillery Studies.

CAPTAIN DYER, R.A., Assistant Inspector of Artillery, Secretary.

MAJOR-GENERAL RANDAL RUMLEY IN THE CHAIR.

Lieutenant HENRY ISACHE, R.A., examined.

2799. (*Chairman.*) You are stationed, are you not, at the battery at Shorncliffe?—Yes.

2800. Have you seen any practice with the Armstrong or the Whitworth field guns?—Yes, I have seen practice with both of them.

2801. Will you describe the results of the practice with the Whitworth gun, and when?—I was present at the practice in October last with the Whitworth gun, when there were four Whitworth guns down at practice at Hythe—Whitworth 12-pounder brass guns.

2802. How many rounds did you fire, and what was the result?—We fired altogether 150 rounds a gun; the targets were moored at sea, and the practice was considered to be good, but we could not form accurate ideas of the results.

2803. What was the range?—The range was from 500, 1,000, and 1,500, up to 2,000 yards. The guns did not appear after that practice to have worn very much. I was not present at the latest practice.

2804. Was there any difficulty in working the guns?—None whatever; they worked very easily indeed.

2805. Were they compared with any other guns at the same practice?—There were some Armstrong guns there.

2806. Was there any comparison with regard to quickness of firing?—Yes; we fired 20 rounds as quick as we could.

2807. What was the result of that?—As far as I recollect 20 rounds were fired by one of the Whitworth guns in about 13 minutes and 40 seconds. The first gun, the Whitworth, had finished by about a minute before the Armstrong.

2808. What did you fire; were they solid shot or shell, or what?—We fired a few shell, not many, they were almost all shot.

2809. With the shell that you did fire out of the Whitworth guns what fuses did you use?—We used Boxer's fuses.

2810. Was there any difficulty experienced, or any inconvenience, resulting from the use of that fuse, as

—No, they would have to be reloaded, but there are very few of them that we have come across so far.

2796. (*Major Young.*) Do you not think that those blisters might have been seen at the first proof in the Arsenal?—No, I imagine that the blister comes after a time, and that it would not be seen at first, and the man who came down and to whom I was speaking about it just imagined the same thing, but he attributed it entirely to the carelessness of one of his men in the manufactory. In fact, he said he had cut open a great number and had found nothing of the sort; but latterly they have found some blistered so that that looks as if the blister had come afterwards.

2797. These were quite exceptional cases, were they not, in the case of those done with the zinc process?—Yes, quite exceptional.

2798. Could you say how many shot in which the zinc process has been adopted have passed through your hands?—I cannot tell the number but all have passed through our hands that have come down to Devonport.

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compared with the fuse used by Sir William Armstrong?—No; the fuse was exactly the same as was used with the old smooth-bore gun.

2811. But on the occasion of that practice you had some Armstrong guns; what fuses were used with those guns?—They were fired with time and concussion fuses, I believe; I had nothing to do with them.

2812. Comparing them with the Boxer fuse, was there any appreciable difference, so far as the use of that fuse was concerned?—No.

2813. Was there any advantage which the one fuse had over the other?—The concussion fuses which were used with the Armstrong guns were the most accurate.

2814. You mean the most accurate as to time?—Yes; the result was better than with the Whitworth gun and the Boxer fuse.

2815. (*Col. Taylor.*) Did you see any instances of the time fuse with the Armstrong gun firing on that occasion?—I did not watch them.

2816. Do you know what patterns they were using; were they the new time fuses or the old time fuses?—I do not know; I was in charge of the Whitworth gun.

2817. Had you any fuses with the Whitworth gun which failed to ignite?—Yes; there were one or two.

2818. Do you remember how many rounds of shell you fired, altogether?—The gun that I was with I think fired 10 rounds.

2819. Were they shrapnel or common shell?—They were shrapnel.

2820. On the plan proposed by Captain Boxer?—Yes.

2821. What was your impression of the effect of that shrapnel shell?—I did not think that the result was equal to what I had seen with the Armstrong gun.

2822. Had you no means of judging with reference to the targets afterwards?—No; they were moored at sea, and we did not see them afterwards.

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2823. Did you see any instances in the course of your firing of the fuse of the shell igniting a considerable time before the contents of the shell were delivered by the explosion of the shell?—Yes.

2824. Did the shell travel some way after the explosion of the fuse?—Yes. I saw one or two instances of that.

2825. Had you any instance of difficulty in ramming home the hexagonal shot?—Not the least; we could ram it home with our hands by pushing it from the muzzle.

2826. What was the weight of the gun that you were firing?—There were two sorts, one was 11½ cwt. and the other 14½ cwt.

2827. Do you think there was any difference between the action of the two guns?—I did not think so at the time; they seemed to fire about equal.

2828. Was the charge different?—No, the charges were the same, 1 lb. 12 oz.

2829. Was the recoil greater with the larger gun than with the smaller one?—Yes; rather more so than it was with the smaller one.

2830. (*Col. Simmons.*) You spoke of the shell travelling after the bursting of the fuse, was the charge in that shell intended to burst the shell or merely to throw the contents of the shell out of it at the front?—To throw the contents of the shell out of it.

2831. You would not expect to see the shell burst at the moment of the bursting charge exploding, would you, but you would expect merely to see the shot or the segments thrown out of the front?—I should expect to see them thrown out.

2832. And there would naturally be an appreciable time between the firing of the fuse and the perceptible effects produced by it?—Yes; but it struck me at the time that there was a longer interval than there should be between the bursting of the fuse and the contents of the shell being thrown out. Some of the fuses worked very shortly.

2833. The contents of the shell would naturally fly, would they not, with the shell itself for some little distance; is the charge sufficiently large to throw the segments or shot out of the shell with great rapidity?—As the bursting charge acts equally on the bullets in front of it and on the base of the shell, the shell would be retarded and the bullets thrown out at once if it acted properly, and from the height at which the fuse burst the bullets would have been more scattered if the bursting charge had acted rightly.

2834. Did you experience any difficulty in sponging that gun properly?—Not the least.

2835. You also stated that after firing 150 rounds with the Whitworth gun the gun did not appear to have worn very much, did it appear to have worn at all?—The edge of the grooving, which was formerly quite sharp, was a little rounded; it was not so sharp as it was before the guns were used.

2836. Did you observe which edge of the grooving it was, whether it was the bearing edge, where the shots come out on the other edge?—Both the edges were a little worn.

2837. That was a brass gun, was it not?—Yes.

2838. Were the shot prepared in any particular way; were they steel or merely cast iron?—Those are the shot on the table (*pointing to the same*); they were all exactly the same.

2839. (*Commander Singer.*) Was that broken shot which you see before you one of the shot fired on that occasion?—No; that was fired at the later practice.

2840. Do you know how the breaking of that shot is to be accounted for?—I was not present at that practice. I did not see it all.

2841. Were those Whitworth guns mounted on the service carriages?—Yes, the usual carriages.

2842. Was the charge the same as that of the Armstrong gun, 1 lb. 8 oz.?—No, it was 1 lb. 12 oz.

2843. Did you not say that both the Armstrong and the Whitworth guns were all fired with the same

charge?—No; the two sorts of Whitworth guns were fired with the same charge.

2844. Did you take particular care of the shot, so as not to allow them to get rusty?—They were not rusty; they were rubbed over continually from time to time.

2845. Were they lubricated in the least?—No.

2846. They were merely kept clean?—They were cleaned from time to time to keep the rust off.

2847. Were they thrown on the shingle before firing?—No; they were carried straight from the limber box.

2848. Do you know what elevation you gave that gun for the 2,000 yards range?—An elevation of 4° 16', we generally had to give it rather less, we found that that rather exceeded the range.

2849. (*Major Young.*) With regard to the wearing of the gun by friction, you state that you fired only a few rounds at that practice, what number of rounds did you fire?—One hundred and fifty rounds.

2850. Did you examine the gun after the practice?—Yes.

2851. And you are of opinion that it was worn?—Very slightly; it was not quite so sharp at the edge as it was before beginning.

2852. Was any of the practice very rapid, except the 20 rounds you have mentioned?—No; we find taking the ordinary time to ensure as good shooting as we could.

2853. You stated that the shells that you fired you did not approve of, that you did not like them so well as the Armstrong shells, was it that the lateral spread was not so great?—It was not so great; and altogether the effect did not seem so good in the Whitworth shell.

2854. (*Col. Ormsby.*) What is your opinion about the accuracy?—I thought that the accuracy of the Whitworth gun was very good.

2855. Did you hit the target often?—Yes, as far as we could see, but it is very deceiving; as far as we could see we were making very good shooting.

2856. Had you two guns or one under you?—One gun.

2857. Was the practice with regard to the other guns pretty regular at the same range?—It seemed to be very regular after the first round or two when we got the distance.

2858. Did you remark the flight of the shot whether it seemed to be regular or not?—As far as I could see it was.

2859. Which do you think is the easiest to work, the Armstrong or the Whitworth gun?—The Whitworth is the easiest to work for the men.

2860. Which do you think you can take the sight up quickest with?—I found always that I could fire quicker with the Whitworth.

2861. (*Col. Simmons.*) Were the two guns, the Armstrong and the Whitworth, fitted with the same kind of sights?—The Armstrong was fitted with the cross sight.

2862. (*Capt. Singer.*) Were those Whitworth sights open sights?—Open sights.

2863. Were they at all like the ordinary Miller's sight with the old smooth bore?—Very much like them.

2864. Were those 20 rounds that were fired very rapidly fired at the target?—Yes.

2865. Was it the same target, or a different target?—The same target all the time. I think it was at 1,000 yards range.

2866. (*Major Young.*) How did you manage to get the allowance for the deflection of the gun with the several sights? Had you any arrangement for doing that?—There was a certain amount of deflection.

2867. How did you get it with the Whitworth sights; you stated that they were ordinary sights?—They were not exactly the ordinary sights; they had the deflection scale underneath.

The witness withdrew.



Lieutenant BEST, R.A., examined.

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2868. (*Chairman.*) You are quartered at Shorncliffe, are you not?—Yes.

2869. Have you had any practice with the Armstrong and the Whitworth guns?—Yes, with both.

2870. How many rounds have you seen fired with the Whitworth guns on any one occasion?—There were 30 rounds fired the last time. That was the only time that I have seen them fired at all.

2871. How long ago was that?—A fortnight or three weeks ago the last time we fired them.

2872. What was your range?—We were firing at 2,000, 1,000, and 500 yards.

2873. What description of gun were you firing from?—The Whitworth 12-pounder.

2874. Was it made of homogeneous metal?—No, of brass.

2875. Were you firing shot or shell?—Both.

2876. How many shot did you fire?—We fired 10 rounds at 2,000 yards first, then 5 at 1,000 yards, and 10 at 500, I think it was. I am not quite positive.

2877. Did anything particular occur on that occasion to the gun or the projectile?—That shot on the table was picked up broken, the edges being coated with brass from the gun.

2878. At what distance were you firing when that happened?—I do not know at what distance it was.

2879. Whereabouts was it picked up?—It was picked up beyond the target.

2880. At what distance was the target?—We were firing at different ranges; it was picked up after the practice was over.

2881. Was it near the target?—No; it was some 500 yards or more beyond the target.

2882. Had you any rapid firing on that occasion?—No, it was not very quick, any of it.

2883. You say that you fired some shell on that occasion; were they shrapnell shell?—Yes; that is the only shell we use with the Whitworth gun.

2884. How did the fuses act?—Not at all well. I have a record of some of the results of it here.

2885. Will you just detail to the Committee what they were?—At 500 yards firing, with an elevation of 44° and the fuse at 2, the first shell burst 20 yards beyond the target. The next shell, firing with the same elevation and the fuse bored the same, was 300 yards short of the target. The next shot, firing at exactly the same range and with the same elevation, and with the same bored fuse, was 300 yards over the target, and another one was 100 yards over. I picked some of them out from the range table after we came back.

2886. (*Col. Taylor.*) When those shells which you saw burst considerably past the target, were you aware of any very great period of time intervening between the moment when you saw the explosion of the fuse and the delivery of the contents of the shell; did you see the fuse burst some time before the shell appeared to burst?—No, I could not see that. I was down with the guns, not with the range party. I took these from the range table afterwards.

2887. They were the common service wooden fuses were they not?—Yes.

2888. And where they in the hands of careful men?—Yes, I saw them bored myself.

2889. So that you could vouch for the accuracy with which they were bored?—Yes, I am quite sure of that.

2890. The default was not owing to any irregularity in preparing the fuse.—No.

2891. After the practice, could you detect in the interior of the gun, any appearance of extra friction or wearing?—The gun was certainly a good deal worn at the angles where the sharp angles of the hexagon are cut off\*—in the small piece where they cut the sharp angle off it was worn very nearly round instead of being a very sharp angle (*describing the same.*) If you look at that shot you will see that there is gun metal on it now.

2892. Did you look over the guns yourself?—Every round of this gun I looked over every time before it was fired, and the other gun I had charge of also.

2893. Did you do so to an extent which would enable you to pronounce an opinion on the accuracy of the fire?—Yes, I am certain it was laid properly.

2894. Were you on that occasion trying the Whitworth gun against the Armstrong gun—were the Armstrong guns at practice with you?—Yes; there was a battery of Armstrongs and two Armstrongs belonging to the same battery as the Whitworths.

2895. What was their practice?—Their practice was not as good as I have seen Armstrong gun practice, but it was a great deal better than the Whitworth practice.

2896. Where they firing segment shell?—Yes.

2897. With time and concussion, or only time fuses?—With time and concussion fuses.

2898. Do you know whether they had the old pattern fuse or the modern fuse?—The old pattern one. I do not think there is a new pattern fuse at all at Shorncliffe yet.

2899. You had no difficulty, had you, with the loading of the gun—no checking of the shot in going down?—No, not the least, the shot would go down by pushing it with your hand.

2900. Without using the ramrod at all?—Yes; if you left out a little bit of the shot and hit it with your hand sharp it would close home in the ground.

2901. (*Col. Simmons.*) You stated that the practice could not be worse than it was with Whitworth guns on that occasion; in what way was that practice bad; did it vary much as to range or in lateral deviation?—Chiefly in range.

2902. How was it as regards lateral deviation?—It was very bad in that respect also.

2903. Much worse than the Armstrongs?—Yes, much worse I think with the same range and with the same elevation on the gun, there was as much as 1,000 yards difference between the two shots in range.

2904. Were the two pieces of that shot on the table found near to each other?—Close to each other I believe. I did not pick them up myself, but I heard that they were picked up close together.

2905. Were you present when this piece of the Armstrong gun was blown off which lies on the table before you?—Yes.

2906. Could you relate to the Committee how that happened?—I do not know how it happened; I saw that something unusual had occurred to the gun; I saw it fired, and one or two small pieces flew back, and that piece disappeared altogether; it was picked up between the target and the battery afterwards, about 300 yards from the battery.

2907. Was not that after some experiments had been tried as to dragging the guns in the mud?—We had just dismounted the whole of the two batteries.

2908. Had the guns been dragged about on the ground at all?—They had been on the ground; they were dismounted, muzzled down, and mounted again.

2909. What sort of ground was it?—Sand on the shore.

2910. Where any pebbles mixed with it?—No, it was soft sand.

2911. Was any clay mixed with the sand?—It was chiefly mud and sand.

2912. Do you think it possible that the muzzle of the gun might have been full of it when the shot was fired?—I am sure it was not; the sponge was passed right out of the muzzle of the gun before it was fired.

2913. Are you positive of that?—I did not see it myself, but directly the accident occurred I asked for the No. 1, the man who sponged the gun out, and the No. 1 declared that the sponge had passed a good foot out of it.

\* Vide Report of the examination of these guns, in the Appendix.

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2914. Were you firing in order to ascertain the rapidity?—We dismounted the battery and fired directly the guns were mounted again.

2915. Do not you think it possible that the man in the hurry and anxiety to get the first shot fired might have neglected to pass the sponge out of the muzzle?—I think it was sponged; I think the man told the truth; I think the non-commissioned officer was a man to be trusted.

2916. We are not imputing anything against the man's veracity, but we are asking whether, in the excitement of the moment the man might not have thought that he had done so when he had not?—I do not think there was much excitement about it; it was the last gun that was fired, I believe; every other gun was done.

2917. Have you heard of any attempts being made to account for the accident?—I cannot account for it at all in any way unless there was sand in the grooves, and the sponge will not take the sand out of the grooves; it will take it clear of the tops of the grooves but not out of the grooves themselves.

2918. (*Capt. Preedy.*) Do you know how many rounds had been fired from the Whitworth guns that you were practising with on that occasion, from the time when they were given over from the "Star"?—I cannot be sure; I do not belong to that battery. There were 100 rounds fired with those guns, I think, once before at Hythe, but I was not at the practice.

2919. Has any better practice been made from those guns than on the occasion you witnessed?—I stated that the practice, the first time they tried them at Hythe, was a great deal better.

2920. (*Commander Singer.*) Was the shot practice equally indifferent as the shell practice with the Whitworth gun?—I think the shot practice was the worse of the two.

2921. Was any wad or sabot placed over the projectile?—No.

2922. If, after loading, you raised the trail, do you think that it would start the shot?—Yes, it would have started the shot, because you may unload the gun by lifting the trail up.

2923. Do you think that on any occasion you never did move the trail?—No, I am sure that it was not moved.

2924. In the case of the Armstrong gun, when the muzzle blew off, was there any warning beforehand? had you never noticed any flaw in the gun?—I cannot tell; it did not belong to my battery; but I do not think there was anything wrong with it before.

2925. Is it your opinion that if the grooves were filled with sand it would so check the shot as to account for that accident in the least?—I do not think it would. I think the lead would take the sand out of the bore with it and clear it.

2926. Had you any range table for the Whitworth guns?—There was a range table came down with the guns.

2927. Do you think that that range table is at all correct?—I do not think it is; it certainly made very bad practice with its elevations on that day; but I believe they used the same elevations for the same ranges before, when they are said to have made very good practice.

2928. When you found the practice so bad, did you not alter the elevation?—Yes, a great deal.

2929. In fact, the practice was unequal?—Yes.

2930. (*Col. Taylor.*) With uncertain results at the same elevation?—Yes.

2931. (*Col. Ormsby.*) You stated, did you not, that the guns were dismounted?—Yes.

2932. Which gun came into action first after mounting them again?—The Whitworth gun was first by a long way; one of the light Whitworth's, the 11-cwt. gun.

2933. Do you think that any mud and dirt got into the muzzle of the Whitworth gun?—I know it did. I pulled some out myself.

2934. Was there much of it?—It was in a foot deep into the muzzle of the gun.

2935. Was there any difficulty at all in cleaning it out?—Not the least; I pulled it out with my hand.

2936. Did the shot go home easily afterwards?—Yes.

2937. Just as easily as it did before?—Yes, I believe so. The man ramming it home found it work perfectly easily. There was no remark about its not going perfectly easily.

2938. Do you remember anything about the flight of the shot, whether it went regularly or irregularly after leaving the muzzle of the gun?—I saw two or three of the Whitworth shot go very irregularly indeed.

2939. In what way?—I saw two or three of them curving about in the air in a wonderful way. In the case of one of the first shots that we fired when we were firing off the bank, I could see the shot the whole way, and it curved two or three times.

2940. Do you remember at 2,000 yards what was the lowest elevation you gave it?—3°36' degrees.

2941. What range would that give?—At 3°36' it was 110 yards under with the first shot. There was 3°50' put on then, and that was 800 yards over.

2942. (*Major Young.*) Did you look over the gun on each occasion?—Yes, at 4°20' it was 300 yards over, and at 4 it was 250 yards over.

2943. (*Col. Ormsby.*) Had you the command of one gun or two guns?—Of two guns.

2944. Did you lay those guns yourself, or did the Nos. 1 lay them?—I laid them a good deal myself, and I looked over them every time before they were fired.

2945. Do you think that they were laid as well as it was possible to lay them?—I am perfectly sure that they were.

2946. Do you like the sight of the Whitworth gun better or less than the Armstrong sight?—I think it is quicker to lay with, but I do not think that you can lay with such great precision as you can with the sight of the Armstrong gun. In very bad weather, with the wind in your face, it is very bad.

2947. What sort of weather was it that day?—Very windy.

2948. Was there rain as well as wind?—There was a little sleet at times.

2949. Which do you think is worked the more easily by the detachment, the Armstrong gun or the Whitworth gun?—I do not think there is any material difference between the two, but I think, if there is any difference at all, the Whitworth gun is worked quickest. I think the Whitworth has the less work of the two for the detachment, if anything.

2950. Supposing the Whitworth gun to be the same weight as the Armstrong, which do you like the best yourself, having worked with both?—I should like the Whitworth best as far as working goes, but I should not like it for practice.

2951. Take it for all the purposes of our service, for instance, which should you prefer?—I do not know which I should prefer. I should like the Whitworth gun best, I think.

2952. For what reason?—Because so many of the others have burst, and cracked, and gone in different ways.

2953. Which principle do you prefer, the breech loading or the muzzle loading?—The muzzle-loading principle.

2954. Is there not a great difference between the precision in the accuracy and the range? The accuracy of the line was pretty good of the Whitworth guns, was it not?—Very fair, in comparison with the range.

2955. And the inaccuracy was in a lateral direction, was it not?—Chiefly; chiefly in the range.

2956. Did you hit the target often with the Whitworth guns?—I do not think it was hit once, or not more than once, if it was hit at all. It was knocked down by a Whitworth shell at 500 yards.

2957. That was the first shot that was fired, was it not?—Yes, the first shot of the Whitworth that was fired.



2958. (*Col. Simmons.*) Those Whitworth guns were of two different patterns and two different weights, were they not?—Yes.

2959. Was the difference in the weight caused by the difference in the length, or was there any difference in the length of the two guns?—I think they were of the same length.

2960. Are all those facts which you have stated to the Committee with reference to one day's practice with the rifled guns?—Yes.

2961. Have you had any other practice with them?—No, I have never been with them since that.

The witness withdrew.

Adjourned to Thursday next at 11 o'clock.

Thursday, 26th February 1863.

PRESENT :

MAJOR-GENERAL RANDAL RUMLEY.  
COLONEL ORMSBY, R.A.  
COLONEL TAYLOR, R.A., Commandant School of Gunnery.  
CAPTAIN PREEDY, C.B., R.N.  
COLONEL SIMMONS, C.B., R.E.

COMMANDER SINGER, R.N.  
MAJOR YOUNG, R.A., Director of Artillery Studies.  
JOHN PENN, ESQ., F.R.S.  
WILLIAM POLE, ESQ., F.R.S.

Secretary :—CAPTAIN DYER, R.A., Assistant Inspector of Artillery.

MAJOR-GENERAL RANDAL RUMLEY IN THE CHAIR.

JOHN ANDERSON, Esq., further examined.

2966. (*Mr. Penn.*) We were examining you the other day with reference to the building of the gun, and the strength of the coil ; I do not understand very clearly your opinion upon that method of building the gun, whether some other system that you might have to suggest from your experience would be better?—After reading over my evidence, which I had last evening, I confess that the impression left on my mind was that, although I had often during the day spoken of various points that this question refers to, I do not think that it came out so clearly as I imagine I could put it in a few words. I did not consider the construction of the bore by the coil system good or satisfactory ; that I thought an inner lining, made out of solid forging, and bored out, so as to leave a shell, which had been well hammered, as the inside of the bore, would be very much better ; but that at the same time, I did not think it nearly perfect ; that the perfect bore would be of cast-steel if we could arrive at cast-steel (and I think we have arrived at it), it would have the necessary hardness, and at the same time the necessary toughness to stand the effect of the firing ; steel is stronger than iron in every way, always providing that it has the necessary elasticity and toughness. A gun made of steel entirely would be the best if we could venture upon it, but judging from my own experience I have not yet seen sufficient of steel to warrant me in recommending an entire steel gun at this moment. I have seen a great many steel guns that were all that could be desired in every respect, but we have had so many disappointments with other things made of steel that I feel diffident in saying that we could now go on to steel gun making with the certainty that it would always be carried out ; but at the same time, I think that it will be carried out eventually. For the inside of the gun it is perfect with wrought-iron outside ; I do not know any way of getting a stronger structure over steel than by the coil system, which I think is exceedingly handy, and is well fitted for that particular application.

2967. Taking the system as hitherto adopted in coiling, what proportion of mechanical failures at proof have you met with, taking it as a per-centage or in any other manner you like?—That question was put to me at the last meeting, and I had not the data

2962. (*Capt. Preedy.*) Were you firing at sea on the occasion you refer to?—No ; on the sand along the shore.

2963. You stated that you thought that if the gun were much depressed after loading the shot would come out of the gun ; did you ever try it?—Yes, we tried it on Saturday.

2964. Did the shot come out?—Yes, quite easily.

2965. Had it no grip of the rifling?—No, it came out very easily. We tied it to a bit of string the first time, and it came out very easily ; the second time we sent it right home and tipped the trail up and it came out quite easily also.

with me, but I am now prepared to answer it ; I had some difficulty in getting the information as to the earlier years, but last year I have what it was exactly. I have before me a return of the Armstrong guns made in the Gun Factory, with coiled tubes for the inner lining, and I find that out of 121 110-pounders constructed during the year 1862–63, there were  $12\frac{1}{2}$  per cent. that failed before proof, and 12 per cent. at proof, that is to say, the latter came back from the proof so that we were obliged to condemn them ; the others we condemned before they went to proof, because little specks came out in the iron ; that makes it  $24\frac{1}{2}$  per cent. of the 110-pounders. Now as to the 40-pounders the per-centage is rather higher for some reason or other, it is difficult to account for it, but we have been more unfortunate with them. Of 201 40-pounders that were made we had 16 per cent. fail before proof, and  $12\frac{1}{2}$  per cent. after proof ; 16 per cent. we condemned before the guns went to proof, and  $12\frac{1}{2}$  per cent. came back condemning themselves by defects that were found in them. I would here remark in passing that although we condemn a gun it often goes against one's nature to condemn it because the defect is so little that we condemn them for, and that of course brings up the number. We have to be so particular, that if there is anything the matter at all, and we detect it, we must condemn it. Then going to the 9-pounders, 131 of them were made, of which 19 per cent. were condemned before proof, and 10 per cent. at proof. Of the 6-pounders, 29 were made, none were condemned before proof, and  $10\frac{1}{2}$  per cent. were condemned at proof. Taking the average would be 15 per cent. before proof, and  $11\frac{1}{2}$  per cent. at proof ; of the entire number last year, we are now better than we were. At the same time I must correct what might convey a wrong impression to the minds of the Committee that this was something in addition to the cost of the gun. It is not so. The cost which we give in the balance sheet, and which comes out before parliament includes all these per-centages, all the materials, and all the labour involved in those rejections are all charged.

2968. Is there not in your opinion considerable difficulty in welding the long tube by heating it?—If you watch the welding of the coil, you will see

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the whole theory of it just by one observation; you will find that it is closing at the ends at the first blow, at the second blow it is closing further down, and further up from the top and the bottom, and about the third blow it reaches the closing of the rifle.

2969. It is a little cooler than when it first comes out of the furnace, is it not?—Yes; but more than that it is showing us that the effect of the blow is not quite so great, having a cushion of soft red iron between the coils which you do not reach. Of course if we could have our hammer so constructed that we could have an enormous weight, but hardly any blow so as not to act locally at all; in fact if it were done by pressure so that it came down uniformly, and if the iron could be kept from shifting about, then we might come to have it as well welded in the middle as at the ends. We do not know that it is not as well welded in the middle. I have not anything to say against the welding in the middle particularly, except that I do not think it can be quite so well done as it is at the ends. I think I mentioned last week that that part which was welded by a screw uniting the two coils together is always better than the other parts. We do that in the furnace with a bolt through, and I think that that is the best part of it.

2970. Have there been many experiments made with the 70-pounder wedge gun, as far as you know?—No, not very many. There are only two of that kind of gun; one of them was tried at Woolwich a good deal, and I think they were both tried at Shoeburyness; but there has not been sufficient experience with it for me to form any opinion as to whether it is a good gun, judging from the firing that has taken place. And besides, the first or second gun, with all the care which is bestowed upon it, is mostly always better than taking the run of them when the manufacture is entered into.

2971. But the principle of the wedge for stopping the breech is not new, is it?—No; that is a very old plan. There is a gun in the repository made in the 17th century, I forget the precise year, in which there is a very nice wedge arrangement, worked by a lever; and in fact, it is very like some modern guns. But the first that has become very prominent within the last 20 years was the Warendorf single-wedge gun, which was a very good gun indeed. Then came another very much like it, Cavalli's, which I consider was better still, and more simple. That was also a single-wedge gun. The great objection in my mind to the Cavalli principle, was the having to use a hammer to knock the wedge out and in. Then came the Church and Goddard double-wedged gun, with two sliding wedges, very like the Armstrong principle, arranged rather differently, but still very much like it. Then came Sir William Armstrong's double wedge, and then came the gun on the plan which is made on the continent, by Krupp. I do not know who designed it, but it is very simple; it is a single wedge, and there is an eccentric lever for disturbing it when it is fixed in its place, and then it is pulled out and in by the hand. It has always appeared to me that each has some good point, and that a modification of all of them would make as good a gun as a breech-loader can be made. I have not seen one that I think a perfect plan; but if the single Cavalli wedge, the steel cup that Krupp uses to allow the wedge to slide out and in, and the Armstrong hammer, which I think the best plan for disturbing the fixed wedge, and made so as not to run any risk of jamming the fingers, a very good arrangement could be made. The cup should be sunk in with the back to the gun, and not the cup going into the gun; because if the cup goes into the gun, you must have the plate to shift about so as to get it into the gun; but if you reverse the cup and make it larger, so as to make it the size of the end of the inner barrel, it would be an improvement. I will make a sketch (*making a drawing*). This represents the bore. I now draw the cup. This cup is sunk

into the wedge. Suppose this to be the line of the end of the gun where the wedge slides, and that this cup is sunk into that, the gas gets in behind and pushes the cup against the end of the gun. That part is never out of order, and is never in the way, and it is protected, so that nothing can hurt it. Then the Armstrong hammer introduced here to knock that wedge backwards and forwards would be a very simple thing, and I think it would combine the advantages of a number of plans. In the Krupp plan they use an eccentric, and there is a great long lever sticking out, which is apt to get knocked away. In the Armstrong hammer it is very snug inside, and out of the way. Cavalli used a large copper or lead hammer to strike it with.

2972. (*Col. Taylor.*) Did not Cavalli's wedge, in the first instance, depend upon the shock of the explosion to loosen it, by acting upon three inclined planes?—I do not remember that; it is not of that form now.

2973. (*Col. Simmons.*) What is the depth of the cup?—About five-eighths of an inch. The reason I would recommend this, because it is so well sheltered from any injury, there is nothing can harm it; it cannot come out; it is in that recess, and remains there; and then it pulls backwards and forwards as if it was a solid. At the same time it has all the influence of an expansive leather, and being made of good steel, it springs up and shuts up this corner. This is the corner to shelter, and it answers well.

2974. There would be no powder in this part at the time of the explosion would there?—No, only the gas of the powder; not powder itself.

2975. Would not it cause a very heavy blow on the wedge having that cavity filled with powder?—You need not have any cavity; you can fill up the whole except enough to enable it to get in.

2976. (*Chairman.*) That gun has not gone away yet, has it?—No. There are two or three in the Arsenal which have the cup, and one or two which have not the cup; it would not get knocked about. A fine cup that has to be put out and in is sure to be damaged.

2977. (*Mr. Penn.*) Supposing that the wedge and the screw were equally good, would there be more difficulty in keeping the facings of the wedge gun in order than of the screw gun, or would there be more tools to be used; how would you keep it in order in the field?—A question was put to me last week about the facing implements, and their weights, and their bulk. I have prepared a paper (*delivering in the same*), containing the weight and the bulk of the box, and the facing implements necessary to repair the different guns, and also the price, but I do not attach much importance to that. As regards this particular gun which we are now speaking of (the 70-pounder), I have before me a tracing of the arrangement which has been proposed to repair it. It think it will be self-evident, if we look even at that rough sketch (*producing the same*), that we must have the end where the cup comes perfect. If there is any guttering at all, the gas will get past, and it will be quite useless. This gun must be kept up to the wedge, for there is no compensation; if we were to introduce compensation into the gun—if we introduced the shifting of the surfaces so as to set it right, it would be a very complicated structure. We have a little compensation now; we have the wedge a little longer than is actually wanted, but still that is very little—not above the two hundredth or the three hundredth part of an inch. It is necessary to introduce an apparatus to bore out the part, in order to put in the touch. Of course a bouch is bad, but if the surface is wrong it is not so bad as that is. Here is an apparatus supposed to be fixed on to the end of the gun (*producing a drawing*). We first want to bore it out, and after it is bored to the gauge, it has to be screwed, and, in order to bore it we have here a long pinion on a handle, giving motion to a wheel, and this is a screw apparatus that would fit up into it when we come to the screwing. Then this wheel is fixed to the spur wheel, and that



becomes a guide screw to cut the screw in that way (*describing the same*). There is no avoiding that. I do not see how we can get rid of it; it requires a bouch here to steady the end of the instrument, and a thing to hold the whole of the apparatus. After we screw the bouch in we have to bore it out very nicely by the apparatus again, and then we require a conical plug to go in by a monkey sustained like this (*describing the same*), to drive it home. If we do not do that there is no screwing and fitting the screw; the gas will get in and quickly destroy it; it is therefore necessary to get it set up altogether. Those things weigh 14 cwt.

2978. (*Col. Ormsby.*) Does that accompany every gun?—No, not every gun. If we had the gun in the factory we could do it in a lathe, but this is the whole apparatus of the lathe concentrated with the monkey. I daresay we might substitute a lever for that, but then the lever would not cut so nicely.

2979. (*Mr. Penn.*) Then is the Committee to understand that this mechanism would be necessary to be carried on to the field whenever those guns were used?—I do not see that the guns can be repaired without something of this kind. Whenever the 70-pounder has to be repaired, something of this sort is wanted to repair it with. It might do a good deal of service without being repaired, and might come home to be repaired, and then of course it would be done with the lathe; but that is a very formidable thing.

2980. (*Col. Simmons.*) Those are very complicated tools, are they not?—I dare say one might think so; they are very accurately made, but they are very simple.

2981. You could not make them, except in the factory, where you have the best of tools, I suppose?—No, they must be as well made as it is possible; everything has to be true about those surfaces; in fact the amount of truth that is necessary to make the thing answer well should be perfection; there is no satisfaction unless it is perfection.

2982. (*Col. Taylor.*) That cutter (*pointing to a part of the drawing*) is, I presume, upon a scale; is that the extent to which it would take out?—No, it would go farther than that. (*The witness described the same on the drawing.*)

2983. (*Col. Simmons.*) With that cup, which you were describing just now, do you anticipate that it would be necessary to continue to bouch the bore of the gun at this part (*pointing to the drawing*)?—With that particular cup, the part that would be likely to gutter would not be exactly the part which would be likely to gutter with the tin cup which Sir William Armstrong uses. Supposing this to represent the end of the Armstrong gun (*making a drawing*), that cup comes in here, and has to be taken out, and in the course of time this corner of the cup is too apt to get a little injury, and if that corner gets an injury, the gas will get past that corner, and there is a gutter at once, and the moment the gutter begins it will very soon gutter all the way down. With the other cup I do not think that the tendency to gutter would be so great, from the circumstance that this cup could be kept more perfect than that cup could be. There is no reason why this should not be permanent. I have made a steel cup of this kind, and tried it a great number of rounds continuously with one of the guns, and it answers very well; but there is no doubt that the chances of getting the corner injured are very much greater than in the other plan. There is a great objection to this, too, in keeping a larger surface perfect; that is all against it; but its being so well sheltered is all in its favour.

2984. (*Mr. Pole.*) You get a much larger pressure on the back of the gun, do you not?—Yes.

2985. (*Col. Simmons.*) My object in asking that was with a view to know how often you think it would be necessary to use those implements?—No one has any experience of that as yet.

2986. (*Mr. Pole.*) Would it facilitate it if a little bouch were screwed in originally, which, when it

was taken out again, would leave the screw there?—Yes; but you want to bore it out still; you want a screwing apparatus in the apparatus to feed with; you want some feeding apparatus.

2987. You would not want to screw it again if the thing was tipped already?—No; but you want to bore again, and you must have some screw to feed with, there being no screw in the gun. That is the reason why this becomes a more complicated apparatus than that for the other, because there is a screw in the other that we can bore with. Then, again, I am not quite sure about this thick bouch that I have put into this drawing. Sir William Armstrong has put in a very thin bouch, for a very important reason, that it presents a much smaller area for the gas to act upon. The bouches which have been put into the guns, instead of being so thick, as I have shown them here, are thinner in proportion, so as to give a very small area when the gas gets hold of this end (*pointing to the same in the drawing*).

2988. (*Col. Simmons.*) Have you had any instances of those bouches blowing out?—No; the bouch is not very serious, because they can easily be rebouched.

2989. You have changed the bouches, have you not?—Yes; at one time it was a thickish bouch, but it was found not to answer, and we have put in an inner bouch, thinner and longer, being more like this, and about half that thickness (*explaining the same*). Although I have drawn in this way, there is a good deal to learn about it whether it would answer so thick as that; it is not nearly so simple a thing as it appears in the drawing. The difficulty of getting a perfect breech-loading gun is a very formidable one.

2990. (*Major Young.*) If you had a steel barrel altogether, would that obviate the necessity of a bouch?—I think if we had a steel lining and Krupp's wedge, with the sunk cup, we should not be very far wrong. I should like to see that tried.

2991. Has that sunk cup ever been tried?—Yes.

2992. (*Col. Taylor.*) With regard to that sunk cup that you drew just now, do you contemplate it being a permanent cup?—Yes, a permanent cup of steel, and it would be a good substance too. If I had known that this subject would have come up, I would have brought some with me.

2993. (*Mr. Pole.*) It is not a changeable cup of tin?—No, it does not wear out at all.

2994. If it gets broken or damaged what is to be done with it?—It has to be taken out and another put in.

2995. Would you not have a difficulty in getting it out?—No; you can lift it out with your finger.

2996. If it were broken would it not be liable to stick in, and cause a great deal of trouble in getting it out?—I do not suppose so, but I have no experience of it when broken; there has not been one broken yet.

2997. (*Commander Singer.*) Do you think that a steel barrel would obviate the necessity of having bouching?—That would be the most likely thing; the only wrong about it would arise from a gutter, and the gas getting past one of the corners.

2998. (*Col. Simmons.*) It would be very hard steel would it not?—The harder the steel is, always providing that has the toughness which is necessary, the better; it could not be too hard if it has toughness as well. This matter has not been grappled with yet, but it will have to be grappled with.

2999. (*Mr. Penn.*) Taking any breech-loading guns, or taking all, are there not serious mechanical objections, no matter what the plan is, compared with a muzzle-loader?—Yes. I have seen a good many plans, but I have not seen one that I consider would be so perfect as a gun ought to be, but I have sketched out what I think the best, and I have been honest enough to point out the objections to that. An artillery officer or a naval officer is the best judge of what suits his purpose the best, but I have not seen a plan by anybody which I think would give him entire satisfaction. For the smaller guns, as I ob-

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served last week, I have not seen a plan that I consider better than the Armstrong.

3000. But the difficulties increase very fast as you get to the larger guns, do they not?—Very fast. I do not think that the lifting of the vent-piece in the 110-pounder, although it is endurable and can be done is a thing that will give entire satisfaction.

3001. You have seen the Whitworth breech-loading gun too, have you not?—Yes, I have; and I do not like it at all. I am sure that it will not do at all; it could be made to answer, but I do not think it will give satisfaction to anybody for any length of time. I consider that a muzzle-loading gun for its work, if it answers the purpose of the artillery is just about as perfect as any that the materials can be put into; it is just about as perfect for its work as a cylinder and piston is to a steam engine. My remark just now referred to the larger Whitworth breech-loading guns, for the smaller guns it would answer moderately well, not nearly so well as some other guns, but still with the larger guns I do not think that the Whitworth breech-loading plan would do at all. However, I do not think that Mr. Whitworth confines himself to the breech-loading principle.

3002. What is your opinion as to the necessity of covering the shot with zinc, or lead or any soft material, compared to firing hard shot grooved as in Mr. Whitworth's system?—I do not know that I can answer that question exactly, but I will do the best I can. During the last four years, I have been a good deal mixed up with both kinds of shot with iron ribs planed to the grooves, and with shot covered with lead, and I must say so far as I can judge (but I give my opinion upon this point with diffidence), that I would prefer the cast-iron from the tool to the lead coating. With regard to the zinc studs which had been introduced into the shells by different individuals, I have had very little experience of them. But between the other two, I have had an opportunity of judging, and I can now say that those cast-iron shot that were made for the Armstrong shunt gun answer very well, and we have made a number of shot with hard surfaces for other gentlemen, and they have all answered well so far as I have seen, the lead answers uncommonly well, and if the lead gets damaged it can still be knocked down with a hammer, and be passed into the gun; that is greatly in its favour, but a chemical change must go on between the metals, and I do not see how that is to be avoided. It may take a great many years, but the time will come when those will be found deteriorated. The white lead process will go on deteriorating the shell all over the world, and they will sooner or later become unserviceable. With regard to the hard shot, no doubt if we devise proper means there can be no difficulty in producing cheaply the proper surface. I found that in making shell with cast-iron ribs for the shunt gun we produced them at very small cost. I have not any experience of the cost at which Mr. Whitworth can make them, but if he can make them as well as those we did for the shunt gun, they will be done for very little money indeed. I have for some time held this opinion, and that which I referred to last week, of adopting the grooves and ribs and everything without the shunting, I requested Sir William Armstrong to send to Shoeburyness, and they have answered pretty well. Those were all hard surfaces, I prefer the hard surfaces, if any one of them gets a knock that throws up a burr so as to prevent the shot getting into the gun, a file will easily take off the projection that may stand up. There is that liability, but taking it as a whole, if I were to have my choice now I would prefer the hard surfaces, that is to say if we had a steel inside to the gun.

3003. What would be the proportion of the surface in the shunt shot or the shunt gun, to rotate the shot, as compared with Mr. Whitworth's hexagonal principle? I do not understand how the shunt shot is driven round. It seems to be upon a very small surface?—It is done by these faces (*pointing to a shot on the table*).

3004. Is this shell on the table only cast, and not tooled at all?—Only cast. My remarks do not refer to this kind of structure. I have not had any experience of zinc let into cast iron in this way. I have only been mixed up with the two kinds, those covered with lead and those of solid iron.

3005. Has there been much shooting with this shell?—I am not aware; this is quite new to me.

3006. Were the shots true that you fired?—Yes, there were three ribs planed, and they were got up perfectly true.

3007. Have you seen many shots fired from the brass hexagon bore of Mr. Whitworth?—No, I have not. I have seen very little practice with the Whitworth gun. I saw more of it the last day at Shoeburyness than all my other experience put together.

3008. Then you know very little about the trials of the Whitworth guns?—Very little.

3009. What is the largest sized Whitworth gun that you have made with a steel lining, or with a single lining without a coil?—The largest gun with a steel lining that I have had anything to do with has been the 110-pounder; there had been something the matter with the inner barrel; I forget what it was; and I took that gun and lined it with steel, and then used it as a gun to prove vent-pieces, and the inside is as good as ever. With regard to the outside, there is one point about it that looks as if it were yielding somewhere, but the inside is quite perfect.

3010. Have you any idea of what would be the weight of that forging of steel, in the first place?—About 22 cwt. I think it would be a good plan, if we were making steel insides of guns, to get the piece cast longer than wanted, and find out the quality before we put it into the gun. It would be a very safe plan, just getting the forging of the steel longer, then cutting it off, and then taking it at what it is worth.

3011. I understand that you propose to try the steel first by cutting off a piece of what you propose to make so tough?—Yes. I consider that the only thing against steel is, that it is sometimes not what it should always be; and if it is often wrong, it would very soon get thrown on one side in this country. There would be a very great safeguard if we could find out all about the piece before we ventured to put it into the gun.

3012. Have you ever had any of Krupp's steel to operate upon?—Yes, I have had two or three of Krupp's guns, and very fine material it is; not quite so hard as I should like it, but still it is a very fine material.

3013. Still you would prefer that to the coil?—Very much so, for the inside. A remark was made a few minutes since with regard to the steel bearing to be stretched out. It may not be generally known, but so it is, that the steels which are suitable for a gun will really bear to go down from the cylindrical state into the shape of a penny flattened down.

3014. (*Col. Taylor.*) Is that by slow pressure?—Yes, by any pressure that we can put on, if it is the right steel. I have always found that it will bear doing that; and you can judge of that very well by observing its edges. If it is the right stuff it does not crack at the edges, and if it is not right, it begins to crack about the edges; but the steel that will answer the purpose you may be quite sure will bear doing that; very good iron will do it; but it will begin to go at the edges sooner than steel does.

3015. Have you ever considered what would be the probable effect as regards the rendering of the gun unserviceable, of a shell bursting prematurely within the bore, where you have hard metal against hard metal?—If the shells were made of cast iron, we know what they are, and if they were made of a much harder steel (and that is a thing that we ought to get to) the effect would be just as the relative hardness of the two substances. If the steel were two or three times harder than the cast iron, the steel would not be so much indented as the cast iron would be bruised.



3016. Take, for instance, the hexagonal rifling of Mr. Whitworth's gun, do you not consider that the bursting of a shell with a good large charge within the bore of that gun would injure the surface of it so as to prevent getting the next shell home?—With wrought iron it would, very considerably, I am sure.

3017. But not with steel?—I have not had sufficient experience with that; but I feel sure that if we could get a harder steel than Krupp's, it would not be so much damaged. If this system of tempering before we put them in turns out to be a success, and if we get hard barrels in the inside of the gun with their toughness announced, accompanying the hardness, that would be a great thing, and I do think it will come out right before long.

3018. (*Col. Simmons.*) In hardening the steel, do not you sacrifice the tenacity?—One would think that you did, but you do not; you increase in both. I cannot just say the precise figures off-hand without refreshing my memory; but you increase it, I should say, 20 per cent. in the tenacity, and in the power of resisting compression still more so, and you very nearly double the elasticity. At the same time, we have much to learn in the doing of it. A most interesting circumstance occurred in connexion with this very matter only two or three weeks ago. Sir William Armstrong sent up a vent-piece from Elswick tempered in this way; at the first or second round it broke into two halves, and it was said to be tempered. I could not understand it, because I had tempered some, and could not break them, do what I would. I took one of those broken halves, and took it to the hammer, and broke it at the second blow. Then I took the other half, and treated it in my way, and it would not break. We bent it about in every way, and we hammered at it for afternoons, and knocked it about, and altered it in shape, and it is just like a lump of india-rubber; it will not break. But that just shows the nice point of hitting the right heat for the oil. It had been tempered before very nearly the same, and yet it was brittle. Now here it is done by me, a second time, and it has all those characteristics that I have described.

3019. Is that process applied after its form has been given to the steel?—You can bore it very nicely after it is tempered. I thought till within the last two months that the right way to make the gun was this (until I found that we could cut it quite well after tempering the steel) to bore the second tier of the gun conical, not very much, but a little, and then to bore and rifle this piece before we tempered it, and then to take and push it into the gun with 2,000 tons of pressure, so as to drive it home; and this strong mass on the outside would straighten any binding that took place in the tempering. But the experience which we have had in cutting these things after they are tempered leads me now to say that I would not prefer that system. I would rather temper it before we do the actual finishing inside when it is in the interior of the gun. We must not use heat in doing that because we might undo all the good that we did, if we heated the gun so as to shrink it over. That is a point upon which we ought to have a little experience before we should say decidedly that that was the best plan, and we have not had any experience in it.

3020. (*Chairman.*) Will you state to the Committee what the process of tempering is?—It is a very simple matter, and it has been long practised in many branches of art although it has not been put forward very prominently. There was a wrong story altogether got into the newspapers upon this subject some time ago, which led a number of individuals all over the country to write to me what they had been doing, saying that it was not new. Of course I knew that it was not new, for I had been doing it for 30 years in different ways. I was informed by a house which had a great reputation for making steel wire for pianos, that their secret was tempering it in oil and drawing it afterwards. Another house writes to me that they have made the

steel parts of umbrellas uncommonly strong by treating them in the same way. Some one who was making some instruments connected with surgery (I forget what they were) had been using the same process and getting the same result, and a great many things of that kind reached me after that story got into the newspapers; so that I know that it is a good thing; and I am quite sure that it is in many ways. I find that if we raise the low steels, those with very little carbon in them, to the heat that would be suitable for more highly converted steel, and plunge them into oil and cool them in the oil, they acquire a great degree of hardness. When a piece of steel is plunged into any cooling medium the degree of hardness or toughness that it acquires is due in a great measure, and in my opinion altogether, to the rate at which the crystals are obliged to rearrange themselves, and that the oil is the happy medium which suits the steel to give it this condition. I do not think that there is anything in the oil by itself, but in the crystallization which is due to the rate of cooling from the conducting power of the steel as a body; and yet hot-water does not do; and dipping it into soapy water hardens it only, so that there may be something in the oil, but I do not see how that can be considering how short a time the oil acts upon it. It may be in charcoal for a week, and yet it only takes in so much carbon as to make it steel, and I do not see how steel being plunged once into oil, could get the carbon from the oil.

3021. (*Mr. Pole.*) Oil boils at a very low temperature; may it not be a question of temperature in the same way as in railway springs; they have always been tempered in oil, but I have supposed that the object of that was to ensure the particular temperature at which the spring should be cooled?—It is my opinion that it is depending upon the conducting power of the oil.

3022. (*Col. Taylor.*) At what temperature do you use the oil for that purpose?—We use it cold.

3023. (*Col. Simmons.*) How long does it remain in the oil?—Just till it is cold; two or three minutes; it takes three times as long as it does in water; you see it red hot in the oil for a little, and that has a great deal to do with it.

3024. Have you tempered any very large pieces of steel upon this plan?—Yes; up to five inches. I have done a number of the vent pieces of 110-pounders in this way, and we have subjected them to a trial that would break any other vent pieces; we have fired them with a cartridge six inches from the end of the gun; and the existence of that vacant space between the cartridge and the vent piece gives it a tremendous blow.

3025. Have you tempered any linings for guns?—Yes; up to seven inches bore and ten inches in diameter outside.

3026. Do you find that the temper goes right through the middle?—I have taken some of those pieces and flattened them down and opened them out again as if they were india-rubber rings.

3027. (*Commander Singer.*) Do you think that the heat in continuous firing would destroy the temper in any way?—I have not any information upon that subject, but I do not think that it would; but at the same time, though I am saying this, I said before it is a very narrow point whether it may be right, or whether it may be wrong. I have no doubt that the vent piece to which I have referred was very near right, but not being right altogether, it did not answer,—it broke the first or second round all to bits, and I have found some vent pieces of my own which have staggered me, so that I can see there is much to learn in hitting the right point.

3028. (*Col. Simmons.*) That being the case do you consider that the piece which you propose to cut off from the muzzle of the gun, would give you a fair index of what was the state of the steel throughout the mass, even up to the breech?—Yes; that is just what I should like to do. I would take some trusty individual and explain the whole case to him

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as fully as I could, and let him know that the object was to find out that the block was a right piece of steel for a gun, that we were to do this and that and the other thing with it, and I would say to him, "You must do it yourself, and note carefully all about it," and I would have a report before proceeding to use that particular block, just to see whether it fulfilled the conditions which I would lay down.

3029. Did I rightly understand that you would consider that the piece upon which you would experiment would give a fair indication of the whole mass of material that you have operated on, though it might be at a distance of several feet from the place where the principal strain upon the steel might be?—Yes; I could not do more than that. I would have to take my chance after that.

3030. Does it warp much in tempering the steel?—No; very little. There is a very formidable thing which we have to face yet in tempering the gun-barrels. Supposing this to be close to the end (*explaining the same by means of a glass tumbler*), just think of a piece of steel about a foot in diameter with a hole through it to within 2 or 3 inches of the other end. Remember it is a close thing. We all know that if you take anything that is red hot and make one side touch the water or the oil before the other side, there is a risk of shrinking taking place on one side, and warping the thing before the other side comes in contact with the liquid. The whole substance should be enveloped at once if it were possible. If you take that tumbler, say by the other end, and supposing we have it suspended with the other end downwards, you can see that the air would never get out, but if we were to introduce a pipe through the mass sticking up an inch above the water or the oil, the air would pass away through that syphon pipe and get out, but we would not get the oil to the very top, and the part which wanted to be well done, would not be done at all; the oil would not reach it, except what might reach it when it came to be enveloped by the oil from the outside coming upon it. If we made that pipe for letting off the air in the inside drop down, we would get over that, but that is a complicated thing, and a thing of this sort must be manipulated very quickly. Now let us turn it up the other way. We will suppose this to be the close end of the gun and this to be the other end (*describing the same*), and let the other end go down first. Supposing this to be a vessel full of oil, if we dip this tumbler into that oil, the oil would not get to the inside of it, the air which it contains would still remain there, unless we introduce a pipe to go down to the bottom of the oil and away up so as to allow the air within the tumbler to pass outward. If that tube which we introduce is not above the oil, the oil would enter it, and hence it must be above the surface, and if it is above the surface it could not enable the oil to get up to the top of the inside. That seems very self-evident. But we bring it out of a vertical furnace red hot and we have the oil at the proper level, and in heating a thing of this kind made of steel it must be in a retort, it would not do in the fire, if it were in the fire it would get burnt in some particular place. The retort must be at the proper temperature, and we must have the furnace round that retort, and a thing that will remove the air inside of it. Supposing it were red hot, and I want to cool the whole of this at the same time, a very simple way is to see whether we do not get it as well done by dropping it into oil and allowing the oil to come into it when we get up to the outside; that is very simple and requires nothing. But I think it may be worth the trouble to do this, to have in a sling crane, which I have, a barrel made of iron containing oil which is to go into the inside, and to have an arrangement of such a nature, that when we come to the surface of the oil with the bottom of the barrel by pouring on, the oil will go down through another pipe into the inside, so as to keep flowing up around the inside of that central

pipe at the same time that this is going down. I could easily form an outlet to this tank so as to balance the running out of the oil at the bottom. That requires a good deal to be done, but I hope the other plan will answer of just letting it drop and take its chance.

3031. (*Col. Taylor.*) Have you ever tried using the oil at the highest temperature that it would reach?—No.

3032. Do you think there would be any difference in applying it then?—It quite depends upon the rate of the cooling of the metal, and that may affect it.

3033. (*Mr. Pole.*) Did you ever try mercury?—That makes steel very hard. I say that the nature of the steel after being tempered, depends upon the rate at which it has been cooled. Mercury cools very rapidly, and hence it gives extreme hardness. Salt water gives more hardness than clean water, whether it is due to the density of it or to the salt, I do not know, but it does give more hardness than clean water. But why should not soapy water give hardness? That is a thing I cannot see.

3034. How long does the steel remain in the oil bath?—That depends upon the size of the mass. We let it remain in until it is of the same temperature as the oil.

3035. (*Col. Simmons.*) Does the result of this process depend much upon the precise temperature to which the steel is heated?—The steel would very soon be injured by over heating, and there is not any good instrument by which you can say precisely that it is a definite heat. There is nothing very definite in that direction yet. The world has much to learn in that respect. We say that when it begins to scale, that is one symptom of its being the right heat; but that is exceedingly indefinite. Then we say a bright red; that is very indefinite also. It is a much higher temperature than a smith uses to temper a chisel with.

3036. And a very little variation in the steel itself would necessitate a variation in the temperature, I suppose?—No doubt of it; the lower the steel, the higher the temperature that you can go to.

3037. (*Col. Taylor.*) What is the utmost power of the pyrometer that you have now?—I have just bought one that was shown at the exhibition by a foreign gentleman; I got it yesterday; it is a number of clay pieces working into each other. I cannot explain it yet, because I hardly understand it. The inventor says it will suit our hottest furnaces, and that he has used it in Sweden. Daniel's was a very good one; it was a tobacco pipe stretching between two silver rods, and was said to be the best; but I do not think there is anything yet discovered that a furnaceman could use.

3038. You would depend more upon the man's eye, I presume?—Yes.

3039. (*Mr. Pole.*) What is your opinion about the Wedgwood pyrometer?—Everybody has given up the Wedgwood. It was made of clay, which contracted; but there is such a difference in clays that you cannot depend upon that.

3040. (*Col. Simmons.*) What oil do you use?—The oil that we have been using is that called Lucca oil; it comes from Galipoli.

3041. Is it vegetable oil?—Yes, olive oil.

3042. (*Mr. Pole.*) Not whale oil?—No, not whale oil. I think whale oil would do better, but it is more expensive; the other does very well. It would be well to try all the oils. I have seen oil spoken of for that purpose, and some one has been writing to me about it, which he calls sea cotton oil. I do not know what sea cotton oil is. I will get some to try. The writer of a letter to me mentioned a very curious thing, and if it is true it is worth the attention of some gentlemen, that many years ago he had been practising the same thing in a number of boats which he had built with thin sheet iron, and he found that it improved the quality of his iron very much, and what was more, he found that his plates



never rusted when treated in that way, namely, by being put red hot into oil.

3043. (*Major Young.*) Is not that the same process as we have been employing with bayonets at Enfield for some years?—Yes; there is nothing new in the process itself; it is only a little more knowledge gained with regard to it and its extended application.

3044. (*Col. Simmons.*) Do you think that the repeated shocks from firing guns might alter the construction of that steel so as to make it lose its tenacity?—I have not any experience which would enable me to give you a correct answer to that question. I do not think that it would; I rather think that it would remain always the same.

3045. It has been found in practice, I believe, that in iron tires the tenacity has been injured by long use and by the constant shocks to which they have been subject in passing over the road; might not a similar effect possibly take place from the constant firing of a gun?—It might; but I do not think that a gun is subject to the kind of rattling tremor that the tire of a railway locomotive engine is.

3046. (*Major Young.*) Do not you think that in rapid firing there is very great vibration?—Yes, but not to affect it in that way.

3047. (*Mr. Penn.*) Would not it affect wrought iron in the same way?—Yes, I should think so.

3048. (*Mr. Pole.*) In speaking about the coil principle, you restricted your objections almost entirely to the inner barrel, did you not?—That is the only point that I have been troubled with.

3049. You gave some statistics of failures; were not the greater portion of them caused by defective barrels?—Every one of them; there were no other failures.

3050. In no other part of the gun, in the application of the coil principle, except the barrel, have any material failures or defects occurred?—No; we have had no trouble with it, except in that one point only.

3051. So that if your principle should answer, of getting a perfect barrel either by wrought iron, or, still better, by steel, all defects and uncertainty, as regards the coil principle, would cease?—So far as those guns are concerned, certainly.

3052. I understood you rightly, did I not, that you would prefer a gun made entirely of steel, supposing it could be made. What advantage would there be in having a solid steel gun?—I think an entire structure of any one material would be always better than a built-up structure; it would be more simple.

3053. Would it be cheaper, comparing it always with a good built-up gun with a steel barrel and coils around?—It is in the nature of things that a solid gun would be better than a built-up gun, supposing all other conditions remain the same, but I would not use steel until I knew more about it than I know at the present time.

3054. The point of my question refers to a question which I put to you once before; are you not already at the limit of lightness which the action of the gun in regard to the recoil requires; is there any advantage in getting a gun lighter than guns are at present?—If we had a steel that would answer the purpose, and which we were sure would not fail, it would give us great facility in getting a gun to that weight which would suit the artillerist the best, because it is all you can do to screw down to that weight which suits him.

3055. The coiled guns are very light, are they not?—Yes.

3056. And sufficiently strong when made of that lightness?—I do not think they are quite strong enough, although they are very strong.

3057. You would have some advantage if you could have a more tenacious metal in getting a lighter gun if it were strong enough?—I think we are a long way removed from any chance of having any accident.

3058. Putting aside the barrel, is that not practically the case now?—No; if you were using one of those

110-pounders for a long time, you would find it give way in some direction or other, with the change which comes on after a long time. If we were to analyze a 110-pounder, I could show you why it is so; it is not incidental to the coil system.

3059. My question was with regard to the degree of perfection at which you, by long experience, have arrived in the coil principle and the degree of approach to perfection which it attains as to practical requirements. With regard to the wedge system, there are not two wedges in the Armstrong gun; the second one is not a wedge, it is a parallel piece, is it not?—Yes; it is a plate which comes out and gets on the new cup, and then it sticks into the inside of the gun for a little bit, and then you have that broad plate.

3060. There is only one wedge?—Yes, there are two pieces, but only one wedge.

3061. The second one is put on for the convenience of handling, to get the cup on readily, as I understand?—Yes; for a cup of that kind, which has to get into the inside of the gun, it is possible, but still it is not simple.

3062. Then, although the wedge is not new in its arrangement, I am right in understanding, am I not, that the arrangement of this other piece, and the grooves, and the precautions against accident, and so on, are entirely new?—Yes, that is all Sir William Armstrong's.

3063. You stated that there were serious mechanical objections to breech-loading; that merely means, I suppose, that you must have some apparatus for breech-loading of more complexity than in a muzzle-loading gun, and also that there are some mechanical contrivances necessary for repairing the gun. You do not mean that there are any difficulties in the mechanical arrangements for the smaller guns which we have not tolerably well got over?—Just so.

3064. It is merely that there is more mechanical complexity in a breech-loading gun; there are no mechanical objections to the construction of the gun itself for the smaller sizes?—I mean this, that however well it may be devised, there will always be trouble at the joint. It is in the nature of things. The ordinary safety valve of a steam boiler wants grinding up now and then, and in a gun the joint is so severely tried that there will always be trouble at a time when you have not the individuals handy about to put it to rights. If the guns were always fired at Woolwich, I could always keep them right; but when they get away, and the things begin to get leaky, it is a very difficult matter to keep them in order. Then, if you think of an army going over a country where there are no houses or towns to go into, and the guns are tumbling about sometimes in ditches, and the men getting careless, I dare say, and stupid, and everything going wrong, and not coming up, and that sort of thing. It would be a very formidable matter if you were depending upon guns which are liable to get out of order. I think that a gun which will answer must never be wrong in any way.

3065. The matter would resolve itself into a question between the advantages, if there are any, of breech-loading to the service, and the mechanical disadvantages which you have mentioned?—Yes.

3066. That is a question rather to be decided by the service than by us mechanics, is it not?—Yes.

3067. You stated that the objections referred to the larger guns; could you give any definition of the size up to which you think breech-loading is less objectionable; would you go up to a 40-pounder?—Of course with a 6-pounder you can manage; a boy could manage it very nicely. When you get to a 12-pounder I should like to see the vent-piece at least one half heavier than it is, and I should like to see the screw nearly one half longer, and if there was a good breech-piece, I do not think there would be much trouble; the only point that would give trouble with that gun then would be the copper. I think that that gun would give no trouble but with the copper.

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3068. Could not the cup be used with so small a gun as that?—I do not see why it need be pulled out; it might be arranged to go sideways. But passing on to the 20-pounder, the vent piece in my opinion should be heavier. If they were one-half heavier I do not think they would break. If one breaks it shows that others are near breaking. If we had them one-half heavier, I do not think they would ever break; and if the soldier did his duty in screwing them up properly they would never blow out.

3069. Would you go up to a 40-pounder with the breech-loading system?—Yes, we could manage it with a 40-pounder, but when you get above a 40-pounder, they get too heavy.

3070. Up to a 40-pounder those mechanical objections are not so serious as with heavier artillery?—Just so.

3071. You mentioned the white lead process. Is that an idea of yours, or have you seen anything in your experience to warrant you in considering that a serious objection?—No; but I happen to have to pass the piles of shot every day, and I have after rain seen them covered with white, and have in passing put my hand on them and brushed it off like the white on the wall. That shows that the process has begun, and it only wants the horse dung and other constituents necessary to continue the process. I do not know that it is the white lead process exactly; in that process a large extent of surface is covered with horse dung, and in a very few days the lead is covered with white, and is brushed off, and then put it into the same place again. I have seen that white appearance on the outside of the shell after wet weather.

3072. How long have leaded shot been made?—We are speaking with reference to 40 or 50 years. I think 50 years would make a great change in them; some war stores are older than that.

3073. In making a muzzle-loading gun, would you always prefer to make the breech solid?—Yes.

3074. Would you not be more certain of your material in making it hollow and screwing it up?—No, I do not like the hollow at all. My idea of a perfect gun would be not even what I have stated about the solid end in the inner barrel and the thing screwed up against it. I consider that a wrong plan. If I could make myself clear, I would try to explain my idea. If we suppose the outer case of the gun to be solid at the lower end, and no screw at all, most people say that, if you put it in that way, there is a risk of its not being home; and I say that there is very great risk there; but if I follow out the plan which I am now describing you will see that it is an impossibility that it will not be so, at least I think so. The outer case, of course, has to be warmed to enable us to get this in. Let us suppose that that is expanded, we drive the inner one in, and it falls to the bottom; of course, if this part seizes hold of it, it must pull the inner one up a little, and then it would be all wrong (*describing the same*).

3075. Is the second coil which goes on welded of several pieces together?—Yes, it is one piece, but this outer one may seize hold at any point. What I am coming to is this, that if I can make sure of seizing hold of the inner one there, all the contraction of the outer one will go towards pulling the inner one down to the bottom, and the grip that I shall get against the bottom will be greater than anything which I can get by forcing in a screw. If we can manage to throw a sprinkling of water all round the muzzle, and prevent the breech from cooling, then the coldest part will be up at the top, and at the same time make the grip there enormous. I say that No. 2 has to drag itself over No. 1, in order to get down to its natural position. I would have no joints at all at the lower end of the gun, and I would say, have no joints in the breech piece. I would have the coils for the outside of the gun shrinking up at the muzzle of the gun, so as to pull them down to the bottom. I think it will come to that, and that that will be the gun

which will answer. We must take our chance of its sticking sometimes, and making a hold at the wrong place; but if we can get a solid thing without any joint, it will be very much stronger than if we had joints. (*The witness explained his method by a drawing.*)

3076. (*Mr. Penn.*) Supposing a difficulty to arise, why not bore out the first tube with a slight taper in it, and just force it home?—If you could make sure of that, it would be a very safe plan.

3077. Is there not very considerable doubt as to what is going on by the straining on of those hoops?—Not, if you are very careful in measuring; we are getting very precise in that; but it requires a great deal of care.

3078. (*Col. Simmons.*) What is the amount of strain which in the Armstrong system you bring to bear upon this part?—We have it the thousandth part of an inch here, and at this particular part (*pointing to the drawing*) it is five thousandths of an inch.

3079. With the one thousandth of an inch that is equivalent to how many tons' tension to the square inch?—There are about 10 tons per inch called into exercise. I think it is just doing its work from the beginning by that, and if we could have every inch of this structure doing its full work, it would be in the right condition for resisting a universal break-up of the whole, supposing every particle throughout to be at the full stretch, under the limits of elasticity, it works right by that.

3080. Then I understand that, by putting on the outer coil upon the inner coil, you bring a strain of 10 tons to the inch upon the metal of the outer coil, while the metal of the inner one has no strain upon it at all?—Yes; but when the gunpowder gets upon it, it then gets the strain.

3081. Any expansion of the inner coil will tend to expand the outer coil, will it not, and *pro tanto* to increase the strain upon it to that extent?—Yes; but when the pressure comes upon the inside of the gun, you are beginning to counteract the pressure arising from the tension of the outer coils. If the outer coils are under tension from the very beginning, it must be nearer right for doing its duty by pressure from the inside. If we begin with a cast-iron gun, we have the outside doing nothing at the commencement, until we break up the inside; but after we break up the inside, we fortunately encounter this outer shell ready to do the work.

3082. And the result is to change the position of the neutral axis; that neutral axis of course is not at the surface of the bore, but it is some distance from the surface of the bore, and when the explosion takes place that neutral axis comes nearer to the surface of the bore?—Yes.

3083. With reference to the question which Mr. Pole asked you just now; you stated with regard to the 12- and the 20-pounder that you would prefer that the vent piece should be made one-half heavier, and also that the screw should be one-half longer?—A little longer. The five-inch screw we know fails, and the seven-inch screw does not fail; the seven-inch screw therefore is not far removed from failing. What I say is this, that to make it perfectly sure I would take an inch or two more if the artilleryist could allow it.

3084. That addition is where the gun is thickest, and therefore where the metal is heaviest; would not that add much to the inconvenience of the weight of the gun itself, so as to make it more cumbersome?—By taking the metal off at a part where I think it could be spared, I could make a gun of the same weight as it is now, and I would not ask for an ounce more by arranging it differently.

3085. (*Mr. Pole.*) With regard to the plan which Mr. Whitworth proposes of putting on hoops instead of the coil principle which hoops are pressed on cold by hydraulic pressure, have you had any experience of that as a mode of making guns?—No; but looking at it as an engineer I must allow now, even after



all I have been saying about a steel inside, and an iron outside, that it must be wrong as a principle to secure a hard thing by a soft thing. I recommend it because I think it very sure and not likely to burst and destroy those in the vicinity of the gun. At the same time in order to make a perfect structure the material outside should be harder than the material inside. If you reason that out just as a matter of theory, you will agree with me that the material outside should be stronger than the material inside.

3086. (*Col. Taylor.*) Do you mean harder irrespective of elasticity, because of course you require a certain amount of elasticity in the outer coil?—I do not see my way clearly at this moment to being right in theory in what I have been proposing, and what I would stand by now for a long time until I was sure that I saw something better. I like this steel inside, but I like better to have something outside the steel in case of an accident in order to save the men; but at the same time looking at it from a theoretical point of view, and not with reference to the men at all, it seems to me that it is not exactly right in principle to have a hard material within a softer one. I think that it should be the reverse. I do not see my way clear in that, but I begin to think it should be so to be right in principle. We shall not have any practical difficulty in what I have been recommending, but I think that the other plan will be more theoretically right, and what the world will come to some day when the world comes to have faith in steel.

3087. (*Mr. Penn.*) You would take a steel gun and cover it with steel hoops?—I think that would be nearer right in principle, but at the same time I do not recommend it because I have been so often disappointed in steel.

3088. (*Col. Simmons.*) Because you have not yet sufficient confidence in steel?—Yes, that is the only reason; but I look forward to the time when that objection will not exist and that time is not far distant; matters are tending so much towards that point that I think the Government might venture upon steel barrels for the present, and that after a few years if they found it giving satisfaction, steel might be ventured upon a little further if it were to the interest of the Government so to do; but I feel sure that a wrought-iron structure with a steel inside will please everybody in the meantime.

3089. (*Commander Singer.*) Did I rightly understand you to say that there is a considerable advantage gained by having the normal pressure from the outer cylinder upon the inner one, and that that is gained by the process of shrinking in the inner one?—Yes; my idea is this, that if we suppose a gun to be filled with pressure it begins to call out the strength of the gun. It must be that the pressure is greatest in the inside, and that it must have stretched the inside before it reaches the outside; it must act upon all the mass inside before it reaches the outside. Consequently the outside at the beginning is not doing any work until the gun has stretched itself out to reach the strength of the outside. I think that if every inch of the gun throughout were under full work from the beginning the inside would be getting assistance from the outside at the commencement.

3090. Do you consider that the process adopted in the Whitworth-built guns of forcing the outer coils on cold, will give a beneficial pressure to the inner coil?—If they employ sufficient pressure on them in order to get them on conically, they could get the full work out of them; but that is an obscure subject which I am not very clear upon; still I can see glimpses of an immense deal in it to be considered.

3091. You can easily gain that by other means than by shrinking it on, can you not?—Yes, the pressure would do, but I do not think it would be done so quickly.

3092. (*Col. Simmons.*) You have spoken a good deal about steel; can you give us any information about homogeneous iron? can you explain what it is?—It is only another name for steel.

3093. Is the process of manufacture different at all?—Yes. One of the first houses of that manufacture in this country is Messrs. Firth's. I have been over their works, and I understand how they treat it. They are very particular in selecting the iron to convert. I forget the names of the particular brands of iron which they use, but there are certain brands of cast iron made into puddled steel, or may be converted in the usual way in long brick cases which the steel converters use, a time proportioned to the kind of steel required, generally about five days. When these bars come out they are not very highly converted, whichever plan all are cut up into little bits about two or three inches long, and then examines every bit, and is very particular that the heap is all one sort, as near as he can determine. This is melted in crucibles in the ordinary way, and with very great care, in order to prevent any defect, pour it into a great metal ingot mould, and throw the pot away, and then empty the next, and so on, until it is filled. Then it is forged down (for, of course, it is not very homogeneous in this state) under a great hammer, and ultimately it becomes the round cylinder which we are to use.

3094. (*Major Young.*) There is rather less carbon in that than in ordinary steel, is there not?—Yes, very much less.

3095. (*Col. Simmons.*) Is not there a tendency to great variation in the metal caused by pouring in the crucibles one after the other?—I do not think there is much in that; if it could all be done at once it would be better; but it is quite liquid, as thin as water, apparently, and it is all the same material for the same casting.

3096. After it is cooled is it easily malleable?—No, it is not very malleable; but it bears hammering when it is red-hot, so that it is not brittle. I dare say you remember some one took out a patent a few years ago for making cast-wrought iron. I was present at one cast; when red hot, it was about as brittle as cast iron till it got a few coaking blows, and then it changed its condition altogether, and you could hammer away at it.

3097. That was Morris and Stirling's patent, was it not?—Yes, I think it was. It is very curious that the wrought iron would not melt till you threw in a bit of an old file, and then the liquid tumbled down all at once.

3098. (*Major Young.*) Have you made any experiments with Krupp's steel to test its uniformity of structure?—Very little. I have only that lug which broke off a 12-pounder. I pulled it to pieces and compressed it, and all that sort of thing, and I found it very good in point of tenacity, but the softness was much greater than I would like. I should like to get a harder gun. Krupp would not last long inside. They were softer than the wrought iron that we are using.

3099. (*Col. Taylor.*) And not able to bear compression?—Just so. The steel was very low. It was softer in the lathe than anything that I have ever seen turned; it was a most beautiful metal. A perfect metal, but soft.

3100. Could you turn it like brass?—Much easier than brass. But we would get a harder metal than that from Krupp, I dare say. The Bockum metal was as good as anything I have seen. The Bockum Works are just alongside of Krupp's works, I understand.

3101. (*Mr. Penn.*) Have you made many experiments with the process of forcing on the hoops, instead of putting them on by a strain; airing them on or warming them on?—Not very much. I have pushed in the inside in rebouching an old gun. I have been afraid to warm the gun. I have always used the hydraulic press to push them in.

3102. And you have not found them come loose, have you?—No. I would have faith in the hydraulic press if it were strong enough; but it is not so simple or so economical as the other plan.

3103. Do not you think there is more certainty

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about it?—It would be very sure; but I think we can make quite sure enough with our present plan.

3104. (*Col. Simmons.*) You spoke of a very large per-centage of failures in making the Armstrong guns, about 25 per cent. Do you consider those failures to have arisen from the fault of the system, or the fault of the manufacturer?—I must explain again that those were defective insides. It was not that the whole structure of the gun was a failure; it was only the insides that were failures and that had to be taken out; and 25 per cent. of the inner barrels had to be made over again.

3105. Was it from defects in the forging of the welds?—Just so. At various times you will find a little speck wanting here, and a little speck there, and after the guns come from proof you find that some blister in the iron that you do not see has been pushed down by the pressure of the gas, and you can find that there is a hollow place underneath which you have to set right.

3106. (*Commander Singer.*) Would you condemn a gun on that account?—We do not pass the guns if there is any defect at all in them.

3107. (*Col. Simmons.*) The defects in the forging are increased very much, are they not, from impurities in the fuel?—Yes, and in the iron itself; and then sometimes, although the bars of iron look welded, the bars of iron may not be welded at some particular part; but when we are finished we find that there is a line running across, and do not know what that line may be until we cut it out; sometimes it is in the iron itself inside the gun. To be a very perfect gun it should be altogether without blemish. An engineer would not call those defects for engineering purposes, and they would not be considered defects in parts of steam engines. Sometimes there are glaring defects that any one might condemn, but for gun purposes they are supposed to be perfect altogether.

3108. (*Col. Simmons.*) Do you take any particular precautions in the gun factory as to your selection of the coal, to prevent the possibility of the iron pyrites or any impurity of that sort being fixed with it?—We get the very best Hartley coal, and after we get it I have it all picked out again, and during the last three months we have picked out  $6\frac{1}{4}$  lb. of iron pyrites per ton. We cannot take more pains than we do. We have our best men employed upon the guns, and we do not pay them for any bad ones, so that their interest is to make them good. We give a price at first that will warrant a certain number of bad ones, and we have our best men at it, and we pick our coal as I have stated and we cannot do more.

3109. (*Major Young.*) You have had a few failures with the outer coils giving way first have you not?—I daresay we have, but still that can easily be got over, that is not a serious matter at all. We can easily make the outside of the gun strong enough, even if we may not have done so in past times, I am sure we can do it if we put enough metal on, and put it on in the right way.

3110. (*Col. Taylor.*) How do you account for one of those longitudinal fractures of which I have seen an instance at Shorncliffe in a 12-pounder, extending through two or three coils?—I cannot account for that. I think there is something that wants investigating there.

3111. (*Col. Simmons.*) You spoke of 110-pounder steel-lined gun as having external defects?—Yes; that was caused by the firing, and I will explain that in a moment, but I should like to refer back to Colonel Taylor's question. The only way in which the fracture that he mentioned could have originated, was in the breech-piece being in that condition to which I referred last week, that is to say, its being made of two parts very near the point of breaking when it was shrunk on, and that it had broken ultimately, and then the whole work came upon this outer coil. I do not know any way of accounting for it, unless there had been some acci-

dent in the firing, such as something sticking in the gun.

3112. (*Col. Taylor.*) What struck me as being curious was, that the fracture should be continued across two coils, because what connection is there between them?—I could not explain it except in the way that I have now done; but I would not condemn any system from something having gone wrong about one or two guns out of 600 or 700. One must have a precise knowledge of the various points in connexion with this matter, before one can come to a correct conclusion.

3113. (*Col. Ormsby.*) That gun that split outside was fired several times after it had been split was it not?—Yes. I will explain how the 110-pounder that Colonel Simmons referred to went at that particular point. If you look through this gun (*producing a drawing*), you will see that this is the part where it began to go (*describing the same*). There is a great gap in that gun. Then if you draw a line down here, we will suppose that this has been a good fit originally. When you come down here you are very nearly into the heart of the gun, and you have only that little bit there, there is nothing between you and this, and then you are well into the gun, and it is just here where they have all gone (*pointing to the drawing*).

3114. (*Col. Simmons.*) You spoke of their having all gone, have more than one gone in that part?—In those that have gone that is the only point in which they have shown a defect, there have been four altogether gone, and it has been with proof-rounds that they have gone.

3115. Have many been built in this mode of construction?—Yes; a good many hundreds. I have made nearly 1,000 of those guns.

3116. On this principle, and all having that weak point?—Yes; we are only going to make the hook now, but even those ought to be welded. Those other guns that I am making I do in another way altogether, so as to have no occasion for those weak points.

3117. Have those guns been used very much?—Yes.

3118. Have they fired a great many rounds?—Yes; for ordinary firing they do very well, but for the proof-rounds they give way, which shows that that part is too near.

3119. Have any of them given way from continuous firing with the service charge?—No; not that I know of.

3120. Then if I understand you, all the 110-pounders made up to the present moment have been made upon that plan?—Yes.

3121. Are they all included in the return that you put in last week?—Yes; they are all specified.

3122. (*Major Young.*) Were there any other guns lined besides the 12-pounders?—There were some of the Elswick 40-pounders, 20-pounders, and 12-pounders lined in the sense that I am speaking about; perhaps you refer to having a new inside put into them.

3123. I mean bouched as to the greater part of the barrel?—Yes.

3124. The reason that I ask you is that I saw in a return a number of 20-pounders bouched at different lengths of bouches from the vent-piece and also from the muzzle?—It must have been at the very commencement; I have no record of that with me, and I had quite forgotten it.

3125. (*Commander Singer.*) Am I right in supposing that all the trunnion pieces are made from solid forging?—Yes, they are all from the solid forging.

3126. I saw a 20-pounder sea-service gun the other day, and close by the trunnion, after a few rounds, you could push a knife quite clean through into the coil. How do you account for that?—If you look at this drawing, you will see how that would happen (*producing a drawing, and explaining the same*). It must have been defective forging.



3127. (*Col. Simmons.*) You have spoken, have you not, of Armstrong shot with hard ribs?—Yes; the original shot were on that plan for the shunt guns.

3128. Is not that contrary to the shunt principle; is not a soft metal rib essential in the shunt principle?—No, not at all.

3129. Is not the object of the shunt to grip the shot as it passes out of the bore?—On these ribs were placed little points; at that time it had no other work to do but to take this compression.

3130. And were the soft metal points in addition to hard ribs?—They were copper rivets, as it were, let in upon one of the ribs; but those copper rivets had nothing to do with the rifling; they were only for the compression.

3131. So that all those shot had that compressive principle within them, and the soft metal?—Yes; but those rivets had nothing to do with the ribs; they did not do any duty but take the compression.

3132. (*Mr. Penn.*) About what proportion of the coil tubes do you discover bad?—The return of the per-centage of failures before proof would give the per-centage in all the natures of guns.

3133. At what portion of the workmanship was it that you found out the defect: I am speaking always of before proof?—Many times when we find anything imperfect in the inside, what we do is to put it into a lathe, and cut it nearly through, and then we have it brought back to the furnace, and welded there; but after it has been bored beyond a certain stage, you cannot do that.

3134. But still, in rough turning and rough boring the barrels in the first operation, you would sometimes discover a defect?—Yes; that would be embraced in this per-centage.

3135. (*Col. Simmons.*) The Committee have had before them the muzzle of an Armstrong gun that has been blown off, and it is on the table now; have you seen it?—I just saw it, but I do not understand it exactly.

3136. It has been stated to this Committee that this gun had been dismantled in some sand and rolled in the sand; it was then mounted, and immediately afterwards fired, and, at the first round after firing it, this portion of the muzzle was blown off and carried away up near the target. Could you explain the manner in which that accident might have occurred?—No. There has been some very hard work going on here, I can see that; there is a jam of some sort or other there.

3137. If you look at this, does not it look as if some damage had taken place before?—Yes; you can see the line of the weld very nicely; you can see a little bit of it where it has not been properly welded, and that smooth part is a part which I do not like to see; it has not the same hold as the other part.

3138. Do you think it possible that the pinching of the shot near the muzzle, in order to steady it when it is at a high velocity, would have the effect of damaging the welds near the muzzle?—Very likely this would have gone off whatever it had been; there has been a little jam by some means.

3139. (*Col. Ormsby.*) Do you think, if the muzzle of this gun had been filled with sand a couple of inches up, that that would have caused the accident?—Very likely it might.

3140. (*Col. Simmons.*) Does not that fragment look as if it was defective before the accident happened?—If it was not worse than this, there is a good deal of holding-space here; there is a little bit that looks as if that smooth part had not been holding hard, but it had been giving a little.

3141. (*Col. Ormsby.*) Do you think, from the appearance of this piece, that it shows that the gun must have gone progressively?—I would not infer that from this.

3142. (*Col. Simmons.*) There is a Whitworth shot on the table which has been fired from a brass gun; will you examine it, and tell the Committee your opinion as regards the effect of that shot upon the brass gun from which it was fired?—On examining

this shot, I observe the very narrow points upon which the shot seems to have been rubbing in the inside of the gun; hence I would infer that it fitted very badly, at the same time seeing so much brass upon the surface that goes to prove that for this kind of shot a brass gun would not last very long.

3143. Has the shot the appearance of being well manufactured in the first instance?—I do not see anything the matter with it in that respect.

3144. (*Major Young.*) Does the iron seem good?—I cannot judge of rusty iron; there is something wrong about this appearance, because the great peculiarity of the Whitworth is the large bearing surface, and there does not seem to have been any advantage taken of that bearing.

3145. (*Mr. Penn.*) If it had been a less fit that would have been the effect?—Yes.

3146. (*Col. Ormsby.*) In the Whitworth rifling, ought not the shot to come out in a jam, to come out stiffly; it goes in easily, but it ought to come out closely without any windage, ought it not?—Yes, it ought to fit up upon half of the surface.

3147. (*Col. Simmons.*) One-half of that surface ought to bear?—Yes; these are only mere lines on the edges (*pointing to the shell*).

3148. (*Col. Ormsby.*) If the gun were depressed very much it ought to fit so much that the shot should not come out?—I am not sure about that.

3149. (*Col. Taylor.*) With respect to the 12-pounder you stated that there were weighty and bulky tools required to be taken with the gun on service?—Yes; I will put in this return on that subject (*delivering in the same*).

3150. Does that return give the number of pieces?—No; it gives the weight and the bulk and the price.

3151. (*Col. Simmons.*) Do you not think it would be highly desirable if you could fire the Armstrong gun with a larger charge so as to get a more effective result from the higher velocity of the shot?—I do not know so much about that part of the business; it would seem so to me.

3152. If that was so, would not it be a very important thing to have a stronger material in order to enable you to do so with the same limit of weight in the gun that you have now?—Yes, as a general principle that is quite right, if you have a material that you have confidence in in other respects.

3153. A question was put to you as to the limit of the lightness of the gun being determined by the recoil; might not the recoil be checked by mechanical means so that whatever the weight of the gun you might keep the recoil within bounds?—Yes; I could suppose that that was so.

3154. (*Col. Taylor.*) Do not you consider that you have another great difficulty in constructing a carriage to withstand the shock of the light gun?—Undoubtedly that must be so.

3155. (*Col. Simmons.*) If a gun carriage were made of wrought iron, or of a stronger material than wood you might get over that difficulty and probably be able to carry an effective gun into the field with less weight?—We are a long way removed from wrought iron carriages for the guns; there is a great feeling against them in the artillery all through; they do not like the idea of them.

3156. On what account?—I do not know, but the feeling is very strong. I have spoken to a great many officers and they all seem to think they would not like them.

3157. Should you yourself as a mechanical engineer have any objection to wrought-iron carriages?—Most engineers seem to think it is the right thing, but the officers do not like them.

3158. With a wrought-iron carriage do you think we might perhaps adopt a lighter gun or fire a larger charge from the gun without any risk to the carriage?—Very possibly that may be so.

3159. (*Mr. Penn.*) A good deal has been said about the rapidity of the twist of Mr. Whitworth's gun in comparison with Sir William Armstrong's;

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have you anything to state upon that subject?—I would just remark that so far as I can form an opinion the mere requiring a rapid twist is not peculiarly incidental to Mr. Whitworth. If he chooses to have a rapid twist and to have a long projectile going steady when it leaves the gun, he has that which will do it; but he is not obliged to have it so unless he wishes it; there is no magic in the twist nor in the way of rifling.

3160. But it enables him to fire a longer projectile, does it not?—Yes; it enables him to fire a longer projectile, and to keep it steady longer; and you have to take a little more work out of the gun to make it do that. If the artillerist thinks it worth while to have a longer projectile kept steady for a long time he must whirl it up to a high speed; but there is no difficulty about it in my opinion, so far as concerns the gun.

3161. What is your opinion about its distressing the gun?—If you give it a greater twist, you have more work to do so far as that goes, but not so far as the pressure goes; the pressure comes up to its maximum and it would not be any higher even if you held it in after a certain point.

3162. (Col. Ormsby.) Do you think that the shunt principle is better than the breech-loading principle for the larger natures of ordnance?—I never liked the shunt; but it does very well. I must say it is not my favourite plan; every one has some plan that he likes better than others; and I individually like a more simple arrangement, because I think it will do better as a whole. The shunt does very well; there is no fear of the shot sticking as it comes out of the shunt, but it is a complicated gun to make, and I do not see any advantage in it, and why should we go to a thing that is not simple if there is no particular advantage in it. In fact any system may be made to prevent the shot from being stiff going in, it has only to be slack on the opposite and an incline on the other side.

3163. (Mr. Penn.) That would be the case with the Whitworth shot, would it not?—Yes; that would be the case with the Whitworth shot, or the case with Commander Scott's, or Mr. Thomas's, or any plan if they choose to have it so, there is no doubt about that.

3164. (Major Young.) Was not Sir William Armstrong the originator of that idea of the shunt?—Yes, I think so.

3165. I mean that idea of the shot going in easily and coming out tightly?—I am not sure about that; I rather think that years before Sir William Armstrong did that Mr. Whitworth used to shave off one side with that object. I cannot say positively, but that is the impression on my mind.

3166. (Col. Simmons.) In the shunt muzzle-loading gun, the rifling being given by grooves would not you think that it would be more liable to cause the shot to stick in passing down in loading than would be the case with a gun in which the rifling process is given without those grooves?—No; I do not think there is much in that, because that rapid turn which Sir William Armstrong gives to that corner he might easily angle away so as to prevent it sticking there.

3167. I mean from sand or dirt getting in, or the refuse of the powder being in it?—I do not think that there is anything in that; it goes in easily enough, and comes out very well; but there is a chance of the muzzle having to give too much grip in coming out by carelessness of manufacture.

3168. What would be the effect of that grip?—If it was overdone, a sudden grip of that sort might do just as it used to do with the Lancaster gun; but it would not be so bad as the Lancaster, because the Lancaster had so much work to do it would split the muzzle. But in the guns now constructed by Sir William Armstrong, there is abundance of strength to resist a very good pinch.

3169. (Col. Taylor.) That pinch in the case of his lead-covered shell is on the soft metal?—Yes;

but in the shell that we have been looking at this morning, it is zinc.

3170. But that is a softer metal than the iron?—No doubt; but still every departure from positive simplicity is in the wrong direction, unless there is a great advantage in it.

3171. I should like to have your opinion with respect to that very point, as to how far you consider it indispensable to accuracy in a rifled gun that the shot and the bore should be concentric at the moment of the projectile quitting the gun?—If the projectile leaves the muzzle a steady fit, or if it is sufficiently long to take the direction of the bore, and has whirl enough to keep it up and to prevent its wandering, it will be accurate whichever way it is accomplished.

3172. But can that be accomplished without the pinch or nip of some kind; do not you think that, in your rifled system in which that nip is dispensed with, there must be, however small, a certain amount of windage which would destroy the concentricity?—Let us carry it out to the extreme, so as to have two angular surfaces, one on each side; would not it, in jamming on these angular surfaces, always go into a steady drive, tending to split the gun? I see some approximation to that even in the three grooves, or in the six sides, or in the plan of Mr. Thomas's; they all have that angle for the shot to creep up upon, so as to get to some position which gives steadiness to it. I am sure that any plan could be made to give steadiness if it is angulated enough to do it; it is quite a matter of angulating the surfaces.

3173. (Col. Simmons.) Tantamount to the windage being destroyed on those angles?—Yes, on those angles the shot does not wish to turn round. If you drive with the angular surface, it must join up into that angular surface. That is not the best drive. It appears to me that the best drive would be something very different, namely, two straight lines crossing the centre; that would be perfect so far as a mechanical drive was concerned, Clements' driver, as engineers call it. I say that the steadiest drive to make it uniform through the centre of gravity would be to make one of these on this side, and the other on that side. There is nothing to press on this surface and on that (*describing the same on a drawing*).

3174. Then would it be a section of the rib that you would put upon the shot?—Yes; and I say that that is the steadiest drive, and then it drives just across this line. But if we were to angle this line to that, then it gets away, pushing up into this part, and that would bring it into the centre; but then it is bad as a mechanical drive. My attention was directed to this matter some time ago in an argument on the subject of some of those plans that had three surfaces, and the state of the case is this, that if we make a driver with three, unless they are positively perfect, if there is the millionth part of an inch wanting, it will only bear upon the inside, and it will come to be something very much more than that. If there is anything with a hard surface working upon any one of these, if we argue that it will wear these surfaces, then it will be only right the first time, and it will not be right the next. I think the three points cannot be perfect, and you had better trust to a large surface spreading about like Sir William Armstrong's many grooves, or this plan of Mr. Whitworth, so as to get a good deal of surface. This would not last long as a gun; but as a mechanical drive, there would never be anything better than that; but I think it would give that part of the gun too much to do, and would wear too much (*pointing to the drawing*).

3175. (Col. Simmons.) With the two surfaces that you have described, and supposing that they are accurately constructed, and that the line between them passes through the centre, you would have an accurate motion?—Yes; we should have an accurate motion by that means.

3176. With three surfaces, if only two are bearing, you would have an eccentric motion?—I am not sure about eccentric motion; it would be wrong with re-



gard to the gun, but I am not sure that it would be wrong with regard to the shot itself; it would come out of the gun wrong. It would come out, being touched, on one side; one side would give it a little pat as it left the muzzle, and so cause deflection.

3177. (*Col. Ormsby*.) You have stated that you have not, as yet, seen a perfect system of breech-loading?—I have not seen any breech-loading that I would, after considering it well, pronounce to be right in all respects to fulfil every condition that is required. I have not seen any one that comes up to that high standard in my own opinion. I have seen a good many that have good points about them, some better than others, and I think that if all the good points in each one were shaken up together, something good might come out, better than any one individual gun that I have yet seen.

3178. Will you state what you consider to be the best system of rifling for a muzzle-loader?—That is a very puzzling question, and I do not know that I could readily answer it. It is a difficult thing to say which is the best, there are many of them good. I have said that I do not like the shunt; that is something out of the way. I do not positively dislike it, but I do not think that it is quite simple enough; that is all; there is nothing against it particularly.

3179. If we take Mr. Whitworth's system of rifling, what should you say as to that?—If it were a question between that and the shunt gun, I would vote for Mr. Whitworth's, so far as I have yet seen the two systems.

3180. Do you think that both the projectile and the gun being of hard metals, there is a danger of the gun becoming unserviceable from the work upon it?—No, I have not supposed that it would fail at all in that respect.

3181. Where do you think it would fail?—I know very little about the Whitworth gun, but my impression would be this, that Mr. Whitworth likes long projectiles, and in giving them a rapid twist to keep up the motion he gives the gun a great deal of work to do. I think he has tried his guns very much in past times; though, from what I have seen of the 130-pounder gun down at Shoeburyness, that gun may be made to stand, and if that gun stands I could improve it in two or three points. It is a very good gun in one point, but not in others.

3182. Is that 130-pounder claimed to be a Whitworth gun?—The structure of the gun Mr. Whitworth does not claim particularly; but the bore of the gun, and the rifling of the gun, and all that is Mr. Whitworth's; and it is a very good gun; there are very few better guns than that out.

3183. (*Col. Simmons*.) Would you prefer Mr. Whitworth's system of rifling with such a very rapid twist?—Mr. Whitworth ventures a great deal; he expects a good deal out of the gun by giving it such a twist. If the gun is right it will no doubt bear that twist very well from what I have seen of it. It was intended only for a charge of 25 lbs., but it has been fired with 27 lbs., and, if it were a little modified, I think it would fire that without any risk at all.

3184. Is that gun made of homogeneous metal?—No; there is no homogeneous metal about it; it is a solid wrought-iron forging for the inside, and a solid breech-piece for the breech, and all the rest is coiled, except the trunnion, which is made in the ordinary manner.

3185. Do you think that homogeneous iron is a good metal for making guns?—Nobody has occasion to give it a worse name than I have, because I have had my fingers burnt so very often with it, but still I must say that I do not call it by the name of homogeneous metal; that is only a name given to it by some manufacturers. We will give it the name of steel. If it is good, it is very good—very much better than iron; but when it is bad, it is worse than iron.

3186. Is there great difficulty in getting it good?—Yes; we have had difficulty in getting it good up to this time.

3187. You stated in your evidence that up to the 40-pounder the breech-loading system is good. Do you think that there is any very great advantage in having a small gun, such as the 6-pounder or the 9-pounder, or the 12-pounder gun, as a breech-loader?—I would not attach much value to my own opinion upon that point, because it is more for a military officer to say what suits his purpose the best; it would not be so handy for him to keep in good order as the muzzle-loader; but if there is great advantage in using it, it might be worth putting up with certain disadvantages which I know will always accompany it.

3188. Those disadvantages I think you stated before in general terms?—Yes; I went into the particulars last week.

3189. (*Mr. Penn*.) In the shunt gun I understand that the shot itself does not fit the gun, but that it is made to fit by means of strips placed on it.

3190. And therefore there must be considerable windage?—Yes, there is.

3191. Then how is the effect of the windage got over practically, is it by the use of more gunpowder?—Yes; in the original shunt guns there was a great deal of windage, but they have been very much modified of late in that respect, especially the one that I see lying here. There were great gaps in the first guns that came forward, but that has been very much improved.

3192. It seems to me that that shot on the table is a casting out of the foundry without being tooled?—Just so, it has not been in the lathe.

3193. (*Col. Simmons*.) As regards cost, Mr. Whitworth stated before the Committee that the expense of passing the tool over the Whitworth projectiles was about 5d. per dozen. Do you agree with that?—It must have been a small-sized shot.

3194. Do you think that that is a fair estimate of the cost of completing it?—Yes; it would take a great deal of organization to do it at that price, irrespective of good machines, there is no doubt about that; but if Mr. Whitworth said it, I have not a doubt that he has seen the way to do it, because he is very slow to promise anything of that sort, unless he is sure.

3195. Did I understand rightly that he meant completing the shot into this form as projected from the casting?—Yes; I have not a doubt that he would have a number in the machine at once, and as the thing went along a number would be done at the same time, a tool of the full breadth passing once or twice over them.

3196. Completing the shot from the casting?—Yes; and touching them over with a plane.

3197. That is a far less expensive process than that of putting lead upon the shot, is it not?—Yes; it is less expensive than the lead process, but still the same thing would apply to other forms as well as to this form, with Mr. Whitworth's ingenuity brought to bear upon it in the way of scheming machines; but of course the lead process cannot be done at that price.

3198. The lead implies a chemical process, whereas this only implies a mechanical process?—Yes; there is a great deal in the lead, and there is the zincing.

3199. And the first expense of the lead?—Yes; that all comes in to render it more expensive, and even this plan will require more care to be taken of the projectiles stored all over the world than the old round shot did.

3200. Would they be liable to change their form?—We know that cast-iron lying out, even if it is painted, does scale underneath the paint, unless it is very carefully kept.

3201. The same process that is applied to cast-iron would suit these shot would it not?—Yes; I should say that they were worth a little more trouble than was generally given to old round shot. It would not allow them to lie so many years without taking them down, and going over them all.

J. Anderson,  
Esq.

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3202. If you have a more perfect tool you must necessarily have more care taken of it?—Yes.

3203. (*Mr. Penn.*) Would there be any more expense in rifling one of Mr. Whitworth's than one of Sir William Armstrong's guns?—There is no gun that I have had in my hand so easily rifled as the multi-grooved gun. I think that is the easiest of all. I dare say that when we got clever at rifling on Mr. Whitworth's plan, and could use the gun on every side at the same time, we should do it easily; but up to this time we have worked with one tool in the inside, and have spent a good deal more time over it than we should expend eventually, but there would not be so much work about Mr. Whitworth's gun as with the shunt gun, the chances of going wrong with the latter are very great. I have not had anything so difficult to do as to keep it right the first time, because it is difficult to produce those lines which you cannot reach or see, feeling your way to the end of the gun.

3204. (*Col. Taylor.*) You could only do that by the pattern system?—Yes; but it takes a great deal of setting even to make that right. If you observe at the other end of the shunt gun there is a turn over at one side, so as to make it hug at the first going off, and at the extreme further end there is a twist over to the other side. That is a very intricate line to cut, it is a very complicated thing to do, and I dare say that the fear of making a mess of it may operate on my mind to a great extent in making me say that I would not prefer it.

3205. (*Col. Simmons.*) If I understand you rightly the shunt gun has produced equally good practice, has it not?—Yes; so it is said, and I do not see why it should not. I do not see why, as the shot came out (unless anything may be due to that grip at the muzzle), the angle of those surfaces at that time was not sufficient to make the shot go to the centre without any other contrivance.

3206. (*Col. Taylor.*) You do not apply the term shunt to the ramp at the muzzle, but you merely mean that shoulder in the groove?—Yes; just so. That (*pointing to a drawing*) was about the shape of the rib in the early guns, and it was thought that there was sufficient angle in it to make it hug up to the centre sufficiently to keep the shot steady.

3207. (*Col. Simmons.*) In fact it was the plain grooved rifle, with the same shape of groove as this in the shunt, without any shunting or variation in in depth?—Yes.

3208. Was there more than one gun made of that pattern?—Only one gun. I have it down at Woolwich now.

3209. Was it much fired out of?—No; I do not know how much.

3210. The shot had hard metal ridges on them, had they not?—Yes. Sir William's were like that at one time.

3211. Did it require that the whole surface of the shot should be tooled over?—These were all tooled over.

3212. Still it would not be a very expensive process?—I think there can be no doubt about our being able to cast the two ends right, and if we were to touch over the bearing surfaces, that would be all that would be necessary. There is no fear of coming to perfection in the casting before long.

3213. When was it that that gun of yours was made?—Sir William was having three made, and I requested to have one of them made, and I would keep it small enough, so that it could be made into the other sort after the experiment was over. It

is just a little under the size, so that by boring it I can make it a service gun.

3214. When was that?—I dare say that was 15 months ago.

3215. Was it a 110-pounder?—It is intended to be a 7-inch gun, and I suppose it is about  $\frac{3}{4}$ ths of an inch under that now.

3216. (*Col. Taylor.*) What is your opinion of the feasibility of combining in the same gun a smooth-bore and a rifle? Do you consider that a gun could be so constructed as to be available on certain occasions for firing the common spherical service shot, without injuring it as a rifle. You must have a certain amount of windage in a spherical shot; there must be a certain play in the gun. Do you not consider that that would injure the gun for rifling purposes, and that the grooves would suffer?—Yes; I do not see any means of getting a really good gun to answer both purposes.

3217. That is an idea that is entertained by some, is it not?—Yes; but if it came to that it would not be this plan nor yet many other plans that are good in other respects.

3218. There is one of the rifles that has been tried, which I believe claims that invention, namely, Commander Scott's?—Yes, probably that may be so, but the one that I refer to is far better than that. This one had only three grooves of the shunt without the shunting, and all the rest was the plain round smooth-bore. In this gun of Commander Scott's he goes a long way round with these grooves, so that he has little bearing there (*pointing to the drawing*).

3219. The groove in a case of that kind has extra windage, has it not?—Yes.

3220. Independently of the windage that exists between the interior diameter of the bore and the shot, have you not the additional windage of the groove?—Yes.

3221. So that you would require a larger charge?—Yes. A very curious circumstance occurred, which very much interested the officers who were engaged in the experiments with the Lancaster gun in the earlier stages. I remember one day being down with Lord Raglan, Sir Thomas Hastings, and others, and a suggestion was made, How would it do to fire round shot out of that gun? A good many said that it would not answer at all; it has no bearing, and there is no gun worse than the Lancaster in that respect; but with that gun it was found that the practice was better than it was with the ordinary smooth-bore.

3222. (*Col. Taylor.*) I have myself tried the Lancaster brass gun and the Lancaster elliptical bore against a smooth-bore with very different results; the range of the gun was very uncertain, and its irregularity on both sides was very great?—I fear that it would spoil a good rifle gun to make it right for a smooth-bore.

3223. (*Col. Ormsby.*) Do you think that there is a great advantage gained by having the Whitworth shot made tapering at the rear?—I can hardly give an opinion upon that. I do not know much about it.

3224. (*Major Young.*) Do you think that there is any likelihood of injuring the bore from the fact of the gas acting as a kind of wedge, and getting between the base of the shot and the bore of the gun?—No; I do not think so. I would not think that there was such a thing as wedging; it seems to me that there is just a certain pressure per square inch, and that that pressure will exist the same as water does in a hydraulic press in any crevice so many tons per square inch. I would not think that that wedge principle in any shape was at all applicable to this kind of thing.

The witness withdrew.

Adjourned.



Monday, 30th January 1865.

PRESENT :

MAJOR-GENERAL RUMLEY.  
MAJOR-GENERAL TAYLOR.  
COLONEL ORMSBY.  
COLONEL SIMMONS.

CAPTAIN WILSON, R.N.  
CAPTAIN SINGER, R.N.  
MR. POLE, C.E.  
MR. McDONALD.

MAJOR DYER, R.A., Secretary.

MAJOR-GENERAL RUMLEY IN THE CHAIR.

CAPTAIN NOBLE examined.

Captain Noble.

30 Jan. 1865.

3225. (*The President.*) It was the wish of the Committee, Captain Noble, that both Sir William Armstrong and Mr. Whitworth should attend in order to go into the question of the cost of the guns. But we understand that Sir William has sent you on his behalf, and that Mr. Whitworth is unable to attend. Now, what we should wish to do is to ask you some questions regarding the construction of the 12-pounders which have been sent to the Committee for trial, and then anything regarding the expense that you could furnish us with. You are aware that the guns are now named the *A* guns, the *B* guns, and the *C* guns. If there is any difference in the 12-pounders, the *A* gun is that with which we have fired so many rounds?—No, there is no difference in the 12-pounders.

3226. Tell us the construction of the 12-pounders?—The 12-pounder gun is composed of a steel barrel.

3227. (*Col. Simmons.*) The breech-loader or the muzzle-loader?—They are both exactly the same in that respect. Both guns have steel barrels, and they have coiled hoops shrunk over them. I think the drawings which the Committee have in their possession will give every further particular.

3228. Is the steel of which the barrel is made supplied by the trade, or is it prepared in any particular manner at the factory of Sir William Armstrong?—No, it is supplied by the trade. We specify certain tests which we subject all the steel to, and we also treat it ourselves by hammering and various other processes when we get it. But the steel is simply supplied by the trade. I have understood that Mr. Whitworth has said that Sir William Armstrong pays him some patent right on these barrels. I have only got most decidedly to say that that is not the case. No patent right has ever been paid on these barrels, and, in fact, the guns before the Committee have been made in exactly the same way as the first gun made by Sir W. Armstrong. But in consequence of the improvements that have been made by the steel makers since that period (1854), we get a steel far better adapted to guns than we could at that time. As to there being any patent right paid either by ourselves or the steel makers that is a mistake.

3229. Are these barrels supplied to you solid?—Solid.

3230. And do they undergo a process of tempering or any other process after they come into your hands before boring?—Not before boring.

3231. Is the gun built up solid with the steel and the coils and the super-imposed coils before it is bored?—No; the barrel is bored first, and the first thing after the barrel is ready to be bored and turned for the gun is to test it in various places. We cut off pieces and test them, and ascertain if it is fit for our purpose, as far as our experience goes. Our tests are very severe, and we condemn a great number of barrels.

3232. And if I understand rightly, those tests are made after the barrel is bored?—No, not after the barrel is bored; before it is bored. The tests as to the quality of the steel are made before the barrel is bored.

3233. (*Mr. Pole.*) Otherwise the expense of boring would be thrown away?—Yes; at the same time the

Committee are well aware of the various difficulties in getting good steel, and even after the guns are bored barrels have to be rejected owing to faults peculiar to the steel, such as flaws or cracks.

3234. (*Col. Simmons.*) As I understand, you bore the barrels before you put them into the gun?—Yes, but the ingots are tested before they are bored.

3235. (*The President.*) Do you find that the defects you have mentioned have diminished of late, that is to say, that the steel has been improved?—The quality of the steel has been improved, but I can hardly say that I think so. The liability of steel to contain flaws and cracks is excessive. Even for the barrels it requires the very greatest care. We ourselves employ all the greatest makers, including Krupp and Firth and Cammel. I think they are the greatest steel makers we know, and none of their barrels are perfect.

3236. Is the metal improving; have you as many defects now as you had when you commenced?—We have a better quality of steel, more adapted to the purpose, but still the flaws and cracks which seem to arise, some from defects in casting the steel, others from cracks apparently made in the hammering and which you can hardly find out, are very serious. And my remark applies to the experience of the Russian and other Governments; Mr. Whitworth himself has had full as many difficulties with steel as we have; he has had the same things to complain of precisely.

3237. (*Col. Simmons.*) Have you a large percentage of bad barrels?—Yes, very large.

3238. (*Mr. Pole.*) You are confining yourself to the 12-pounder barrels?—No; but I am confining myself to the steel. With the 12-pounder there is very little difficulty comparatively.

3239. It would vary very much with the different sizes?—It would vary very much with different sizes; with the 150-pounders I think at the present moment we are returning as much as 30 per cent. to the makers.

3240. Would it increase in proportion to the size of the mass of steel used?—I should hardly think so.

3241. There is more waste with the large than with the small?—The 150-pounder and the 300-pounder are the difficult sizes. With regard to them the per-centage seems to be very large.

3242. Compare them with the 12-pounder?—It would be a very great deal more.

3243. The defects would be much greater, we know that is the same with iron?—Just so, with the 12-pounder it is not so difficult. Mr. Pole was just mentioning the case of a very large mass of steel which you would have for guns of that size. In the first place the mass being so much bigger, the chances of a flaw being in that mass are much greater. Then, in addition to that there is the particular method of melting the steel; the steel being poured into the mould from a number of pots there seem to be a number of flaws where these various quantities of steel unite; and then finally the hammering is not so effective upon a large mass as it is upon the smaller masses.

3244. (*Mr. McDonald.*) Then in point of fact the uncertainty in the steel is entirely due to the extent and size required?—In a great measure. I would

*Captain Noble.* not say entirely, but in a great measure it is due. As Mr. Pole said, in the 12-pounder, there is little difficulty in getting the steel; but in the 150-pounder and the 300-pounder there appears to be very great difficulty in getting good steel—at least in accordance with our own and others experience.

3245. How is it in the 70-pounder?—It is intermediate.

3246. Up to what point have you got, carrying along with you the element of certainty, as near as may be, in steel?—We have made every gun up to and including the 600-pounder with a steel barrel; but the uncertainty certainly increases with the calibre. In my original remark, I do not know whether I was rightly understood, but I meant to say that when you got ingots of the size of 150-pounders and 300-pounders, the difference between these two is not so great as between the 150-pounder and the 12 pounder, with which we have very much greater certainty; and the number of ingots we reject is very few. I don't suppose more than 10 per cent.

3247. What means have you of knowing with reference to the question of payment of patent right. The Committee of course are bound to accept the statement that Sir William Armstrong makes no payment of patent right: that is clear. But what means have you of knowing that any of the other people who supply the steel commercially to you, do not pay royalty, or are not bound to pay it?—Because we wrote to the makers when we heard the rumour some months ago, and they positively denied that they paid any patent right at all, or that they had any intention of doing it. They said they paid no patent right at all to anybody.

3248. Does that apply to Firth?—Yes, we wrote to him.

3249. (*Mr. Pole.*) All patents are public; and the production of any patent would show it?—Yes; and furthermore, when we looked into the subject we found that the only patent upon which Mr. Whitworth could claim royalty was dated considerably subsequent to the time of the manufacturing of the guns which we made for this Committee.

3250. (*Col. Simmons.*) Do you take the steel for the 12-pounder barrels in the form of ingots, and then cast it yourselves?—They come to us after they are cast and hammered. We do hammer them ourselves to some extent, but only for our special purposes, after we have received them. We get the ingots cast and hammered.

3251. Would you have any objection to describe the process you apply to the steel (confine yourself to the 12-pounders) after you obtain the ingots, describe the process of manufacture and proof of the steel, as far as you think you are warranted?—The proof of the steel is this: we get ingots in a certain form; we generally draw them down. There are exceptions but I am giving the general rule, we draw them down a little more. I ought to tell you that we specify to the makers that so many feet of the head of the ingot must be cut off before the ingot comes to us. They are cast with a dead-head, and this dead-head varies with the size of the gun. A large portion of this ingot is cut off; then after it comes to us it is drawn.

3252. (*Capt. Wilson.*) What is the meaning of "drawn"?—It is drawn under the hammer: then discs are cut from each end of the ingot, and from these discs rectangular bars are cut. Then each of these rectangular bars is placed between two bearing surfaces, and a weight is dropped upon it. Then, the test for toughness is that these rectangular bars must bend to a certain angle, or they are rejected.

3253. Is that weight dropped upon the rectangular bar to test its power?—Yes.

3254. Is the rectangular bar supported between two bearing surfaces?—Supported between two bearing surfaces: and then it must bend to a certain angle. That gives a test of its toughness; and the number of blows which it takes to bend it to that angle is of course a test of its hardness. If its toughness and

hardness are satisfactory the barrel is passed. We have a certain angle for each size of gun to which the steel must bend. This process is performed both with the muzzle and breech end of the gun. The breech end is generally the best steel, because it has been at the bottom of the ingot in casting; and we put the best end of the ingot to the breech of the gun. After that, if the barrel is passed it is bored. It is then very carefully examined for flaws, and if no flaws appear, the boring is finished, and a very fine polish comes upon it. It is then left for two or three days and examined again, when, if there are any small cracks or flaws in the steel which would not ordinarily be visible, the cracks are rendered apparent by the wiping of the oil. Many barrels are rejected from this cause.

3255. (*Col. Simmons.*) That is the oil used to lubricate the tool?—Exactly. Then after this final examination, if all is right, the barrel is passed and put into the gun.

3256. What degree of variation do you find in the power of the steel as cut from the muzzle end and from the breech end, or rather from the dead-head end and from the other end of the ingot?—It is generally much more brittle.

3257. (*Mr. Pole.*) Which end?—The upper end of the ingot; the muzzle end.

3258. (*Col. Simmons.*) Nearest the dead-head?—Nearest the dead-head.

3259. Then having got that boring complete, what is the next process in the manufacture of the 12-pounder?

3260. (*Mr. Pole.*) Before you leave that part of the subject, what is the quality of the steel? Is it steel converted and cast in the usual way?—Yes.

3261. Is it a quality analogous to tool steel?—A very mild steel. You mean it is not made by the Bessemer process.

3262. I mean it is made in the ordinary way?—Yes, melted in crucibles, and run into ingots.

3263. Converted from Swedish iron and melted up and made like ordinary bar steel?—Yes.

3264. But of course a different quality to tool steel?—Yes.

3265. What is the value of steel of that kind—would it depend upon the size?—Yes, it depends upon the size.

3266. Do you object to stating?—There is no objection to my stating.

3267. Of course it varies?—It varies according to the size from 70*l.* to 100*l.* or 120*l.* a ton.

3268. Nothing under 70*l.*—No, I think not.

3269. That is in the ingot state, untouched by the tool?—Yes.

3270. Hammered after casting?—Yes.

3271. (*Mr. McDonald.*) May I ask how long Sir William Armstrong has been dealing with steel for the purpose of making guns, I mean with this form of tube. The reason for my question is that I understand the service is supplied with Armstrong guns which have no steel tubes?—Yes, but some have steel tubes.

3272. What time did Sir William Armstrong begin the substitution of steel tubes for coils?—You are probably aware that he has been making experiments with steel all along. As I have mentioned before, his very first gun was made with steel precisely as he makes guns now; but the very serious difficulties which came in the way of getting sound steel, the great trouble and labour he had with tubes at first, as well as the question of economy led him to abandon the steel for the coil barrels. But he was continually experimenting with steel all through! because I need not point out to you that the advantages of steel for the barrel are great. In the first place it is of superior hardness; in the second place it has no transverse welds which you have with a coil barrel, whereas, on the other hand, its great liability to fracture is its disadvantage.

3273. (*Mr. Pole.*) And its uncertainty?—Yes.



3274. (*Mr. McDonald.*) I want to know when he became so far satisfied, from the experiments which he was constantly conducting, with the supply of steel for small sizes, as to make up his mind that he could abandon the coiled tube and take to the steel tube?—I think he first commenced with large guns in 1862.

3275. With the smaller guns, when?—With the 12-pounders, it might have been at the commencement of 1862; with the 70-pounders, towards the end of 1862.

3276. The 12-pounders at the commencement of 1862?—Yes.

3277. And the 70-pounders at the end of 1862?—Yes.

3278. (*Col. Simmons.*) Before leaving the question of the steel, I should like to ask whether you test the steel that you employ, chemically, by analysis, as well?—Occasionally, as a matter of curiosity, we do, but not as a practical test.

3279. In the tests that you have made, what are the proportions of carbon that you allow?—I cannot form a conclusion. I cannot say off-hand; I have forgotten.

3280. (*Mr. McDonald.*) Do you happen to know what proportion of guns now in the service, breech-loader guns, have steel lining?—Major Dyer will know, because they have been supplying them at the gun factories. I cannot say with regard to them.

3281. As far as Elswick is concerned, the guns now in the service are all coiled?—All coiled, with a few exceptions.

3282. (*Capt. Wilson.*) You have mentioned a matter of manufacture that the tube was of steel, and the coil shrunk over it. You don't mean the whole length of the barrel in the case of the 12-pounder?—No.

3283. How far?—No coils over the chase.

3284. How many layers of coils?—One in the case of the 12-pounder.

3285. (*Col. Simmons.*) The question I was going to ask Captain Noble was, after they had got it into the form of a barrel, what was the next process?

3286. (*Mr. Pole.*) Yes; but we have not quite finished with the steel. Respecting the nature and the cost of the steel used, you have never used any kind of steel inferior to this best quality?—Never.

3287. Never from any puddled process?—No, never.

3288. Nor Bessemer's process?—No.

3289. Nor from any cheaper process?—No.

3290. Have you any reason to know whether any of these cheaper processes would be at all applicable to the manufacture of steel for guns?—Well, I should hardly like to say without experiment. I think the Bessemer process might perhaps be adopted up to 70-pounders.

3291. Have you ever had specimens of Bessemer's steel that you could rely upon?—Yes; but it is uncertain, very.

3292. It would cost much less?—Yes. I think ingots of that size, the 70-pounder and 12-pounder size, would be something between 50*l.* and 60*l.* a ton by the Bessemer process.

3293. Why so high, made by that cheap process?—It is a cheaper process; but, then, they won't supply large quantities and guarantee them sound, at cheap rates. They would probably have to be the Bessemer steel re-melted.

3294. Then you do not anticipate (you know my question is merely one of expense) you do not see much prospect of cheapening the steel used for barrels of guns?—Not immediate. As you are well aware, from the improvements in steel, you may expect it to come down a good deal cheaper. Of course there is a limit beyond which it will not go; but gradually it will cheapen.

3295. (*Mr. McDonald.*) You have no doubt it is the best material for gun-making, and that eventually it will come into large use?—I have very considerable doubt.

3296. You have none for small guns?—Yes.

3297. Why?—We do not trust it, according to our experience.

3298. You trust it in this competition. If you were going to re-arm the service with small guns, which would you use?—Our present construction: steel, hooped.

3299. You would not use a coil gun?—Well, I should call steel, hooped, a coil gun.

3300. Which do you consider the more important part of the gun, the tube or the coil outside?—For strength, the coil outside. We place but little dependence upon the barrel for strength, according to our experience, with steel.

3301. Then you consider the 12-pounder gun which you have brought before the notice of this Committee to be more a hooped gun than a steel gun?—Yes; just so.

3302. And on the ground that the outside of the gun, to the trunnions, is a more important part of the gun than the barrel, as I understand?—Yes. At the same time I may state that in the matter of the 12-pounders, where the pressures are so small and comparatively manageable, I have no doubt a very good gun could be made of simple steel alone. With a 12-pounder that might be managed quite well, I have no doubt.

3303. (*Col. Simmons.*) You stated that your prices of steel varied from 70*l.* to 120*l.* Would that 70*l.* apply to all steel supplied for the 12-pounders, or does your price vary in steel for the 12-pounder from 70*l.* to 120*l.*?—No.

3304. We are going now into the question of the cost of the 12-pounder. Then you would put the price for steel for the 12-pounder at 70*l.*?—Yes. I am giving approximate prices, speaking from memory; and I am pretty sure we have got no steel under 70*l.*

3305. Then we might put the fair average cost of the steel of the 12-pounders at 70*l.* a ton?—Yes.

3306. You described the steel as what might be called a mild steel?—A mild steel.

3307. Would you apply the term "very mild"?—Very mild.

3308. That is, with a very small proportion of carbon?—Yes.

3309. (*Mr. Pole.*) Of course the 70*l.* a ton steel would be in an ingot very much larger than the finished barrel. How much per cent. about is the ingot you purchase larger and heavier than the finished barrel?—Well, I can hardly say. I can tell you with regard to the 150-pounder. The 150-pounder weighs about two tons; I mean the ingot. I should think it would be very nearly 50 per cent., what with boring and turning.

3310. (*Col. Simmons.*) That would apply to small as well as large guns; about 50 per cent., in addition to what remains in the gun?—Yes; about half would remain in the gun.

3311. (*Mr. Pole.*) So that the finished barrel would have cost, exclusive of the workmanship, 140*l.* a ton for metal alone?—Somewhere about that in the 12-pounder.

3312. (*Mr. McDonald.*) I want to ask whether we are to conclude, from the use of a steel barrel in the 70-pounder, that that expresses a recognition of the economy of using steel up to that size, or whether the gun is produced merely as an experimental gun?—No! we have made a great many.

3313. Then you recognise fully, as I understand, the use of steel for the barrels of the 70-pounders, too?—Fully.

3314. The 70-pounder is hooped to the end of the gun?—Yes.

3315. So that the use of the term "steel tube" is more correct as applied to the 70-pounder than to the 12-pounder, for it constitutes more of the term "barrel"?—I think so.

3316. But you have a decided preference, as I understand, in fact it has been marked before the Committee by the withdrawal of the 70-pounder from

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the competition for endurance, you have a decided preference for the 70-pounder steel tube over the coiled tube; the inner tube, I mean?—As far as regards strength, no; but as far as regards freedom from flaws in the steel, yes. Allow me to explain. I mentioned already that in the coiled tube you are very liable to have flaws where the coils are welded together. In these, in firing a very great number of rounds, the gas eats out the flaws, and they produce ugly, inconvenient flaws in the barrel of the gun. It was for that reason, and not for any superiority of the steel barrel in strength over the other, that, as the trial of this particular gun was to include a great number of rounds, Sir William Armstrong wished that particular gun to be used. Because, although none of these flaws might have existed, yet at the same time they *might*; and it was for that reason, and not from any fear of inferiority or deficiency in strength, that it was used.

3317. I wanted to be quite clear about this point. The Committee have before them two constructions of guns, as far as Sir William Armstrong is concerned?—Two constructions of breech-loaders.

3318. I am not talking of the design of the gun at all, but merely of the material; as I understand one gun of the breech-loaders was a 70-pounder coil gun, pure and simple?—Yes.

3319. That is to say it was coiled throughout?—Yes.

3320. There was no steel about it?—Just so.

3321. The other two breech-loaders were coil-guns with steel tubes?—Just so.

3322. The thickness of the two tubes differs, but that is not material; what I want to get at is what I, as a member of the Committee, am to understand. Does Sir William Armstrong pin his faith to the one kind of construction or to the other?—He pins his faith to both.

3323. It leaves us on the horns of a dilemma; at least myself, personally. I do not know which is best?—He considers preferable the steel barrel.

3324. Therefore he prefers a steel barrel?—Yes.

3325. (*Captain Wilson.*) With reference to the price of the steel, the cost of the steel tubes to the makers must vary with the number of ingots that have to be rejected?—Yes. The makers know about the proportion that will be rejected; at least they may hope they will get fewer; but, of course, the numbers will influence the price.

3326. Then your hopes of the price of the steel being reduced must rest on the hopes of the improvements in the manufacture?—Just so.

3327. (*Mr. McDonald.*) Have you any doubt that in a short time all this uncertainty about steel will be resolved and reduced to certainty?—I have very great doubts.

3328. Ultimately, I mean; within a period more or less short? Is it not the fact that what was a very great uncertainty, with reference even to 12-pounders, and with reference even to steel barrels for small arms has become a perfect certainty, or very nearly; so much so that you do not hesitate to employ it?—You will recollect that I said there were two classes of defects in steel. But the quality of steel is very much more uniform than it was some time ago.

3329. It is improved?—Yes; but these flaws, and the peculiar nature of any steel, the mildest that we can get, are such that it will not resist, as wrought-iron will, percussive action. It is on this account, and not on manufacturing grounds, that I doubt whether in any reasonable time we shall succeed.

3330. Then, in point of fact, you do not look forward with a sanguine spirit to any further progress in the manufacture of steel?—Yes, I do; but even if it were improved, I see no advantage to be gained in substituting it for wrought-iron, for it certainly will not come down to the wrought-iron in price, and it has no other advantage in the exterior of guns. It is not so strong to resist percussive action.

3331. I am not talking about the exterior of guns. I am putting it with reference to the barrels?—I have very great hopes that we shall improve in that respect.

3332. Then you think the material can be improved a great deal for the limited use you recommend?—Yes.

3333. And that you would be able to use it for any size of guns?—We do now use it for any size of guns.

3334. There has been great progress in the manufacture of steel?—Great.

3335. And you see no reason why it should come to an end?—None.

3336. Both in price and in quality?—I think so.

3337. Is it not the fact that, until very recent times, steel barrels for small arms were considered dangerous and precarious to use?—Yes.

3338. And that all uncertainty on that subject is now at an end?—I believe so.

3339. (*Mr. Pole.*) Take the analogous case of wrought-iron. Wrought-iron has been made in large masses for a considerable time; but is it not the fact that large masses of wrought-iron must always be, to a certain extent, uncertain in their manufacture. Is not that likely to be more so with steel, because steel has not the power, as I understand it, of welding up those inaccuracies under the hammer which wrought-iron has?—Yes.

3340. (*Colonel Simmons.*) Do you consider then that wrought-iron is much more easily welded up?—Yes! much more easily welded than steel.

3341. (*Mr. McDonald.*) Wrought-iron is wrought-iron by virtue of welding and nothing else. Steel is steel by the absence of welding?—You can get steel to weld.

3342. Does not the element of uncertainty prevail in wrought-iron in the same way as in steel, in proportion to the size?—Not in the same way.

3343. But it exists?—Yes, undoubtedly.

3344. According to the size is the risk?—Yes.

3345. (*Mr. Pole.*) It is when a large mass is forged as in a large gun, that the uncertainty exists?—Yes.

3346. As I understand when you make a large cylinder out of a plain bar by coiling it round, the only uncertainty there can be is in the welds of the bar; because you are perfectly certain of the quality of the small bar?—Yes.

3347. Therefore a large mass, made up of small pieces enables you to insure a better quality than if it were made in one large piece?—Yes.

3348. You would prefer a cylinder made out of a coil to a cylinder forged out of a mass of iron?—Clearly.

3349. (*Mr. McDonald.*) Are all practical men united upon that point stated by Mr. Pole? For instance, unless I mistake, when the coil gun was in process of construction at Woolwich, Mr. Anderson greatly preferred a solid forging for that part of the barrel which bore the strain?—Yes; and they were an utter failure.

3350. Still it is a matter upon which practical men entertain differences?—They have differences; but the fact of the matter was this, at Elswick, in making the coil barrels, we persevered with the difficulties of welding. At Woolwich they thought they could not do it, and they tried wrought-iron barrels. The wrought-iron barrels have been a great failure, whereas the coil barrels have succeeded perfectly.

3351. (*Captain Wilson.*) They were wrought-iron blocks bored out?—Yes; the failure arose from the fact that they were liable to have their defects longitudinally. I think the Inspector of Artillery would give you better evidence, and with more impartiality upon that point than I can. I do not know whether Major Dyer is in a position to do so.

3352. (*Mr. McDonald.*) Are you aware whether the manufacture of wrought iron in masses is abandoned at Woolwich?—Quite, for barrels.



3353. I mean is this failure recognized at Woolwich?—I understand it is quite recognised. As far as I can tell, or give information about a department to which I do not belong, I should say it is quite recognised. In fact I have seen minutes from the Secretary of State which have recognised it completely.

3354. (*Colonel Simmons.*) The coil gun is made up of a number of sections, of lengths of coil that are afterwards hammered together endwise, is it not?—The second tube, but not over that. From that we break the joint and they are not welded together.

3355. Then each tube is not completed in itself?—No.

3356. Then the first tube that is completed in itself. Do you find any difference in the welds where two rings are connected, or are within the coil itself, within the coil of each ring by itself?—I should think there must exist such a difference, and that you are perfectly correct in saying that there would be such a difference; but the end strength would be quite sufficient, and it is not known, as far as I am aware, from experiments. I think a weld has only about 50 or 60 per cent. of the strength of the original bar, the reason being that the weld, although it is perfect in parts, is not perfect in other parts; there are little portions oxidized.

3357. I mean do you find much difference in the welds that go to constitute the ring, and the welds where the two rings are put together endwise?—I have never detected it; but I think there must be such a difference.

3358. (*Mr. McDonald.*) How would you explain the difference between steel and wrought iron?—It depends very much upon the test it is submitted to.

3359. Have you any formula or any mode of expressing it?—No. The tensile strength of the steel which we use, and the tensile strength of the wrought iron we use.

3360. Could you give us that?—I am afraid I cannot from memory. I should say with mild steel the difference is not very great, but of course it is considerable. But the resistance of the wrought iron to a blow is greater than the steel.

3361. (*Colonel Simmons.*) How is that comparative tensile strength obtained, is it by small bars cut out and then actually broken up by tension?—By tension.

3362. (*Mr. Pole.*) The tenacity alone is not a good test; it is not a fit measure of the strength, where it has to stand sudden blows?—Just so.

3363. That is a general proposition, which applies to iron for railway purposes, and much more to gun purposes.—Much more strongly.

3364. (*Mr. McDonald.*) With reference to the 60 per cent., to which the loss of 40 per cent. by wrought iron at the weld is applied, is that loss in tensile strength?—In tensile strength. But you will observe that with that weld the principle of the coil is to put these welds in a position where the deficiencies of strength will not affect the strength of the gun, that is the whole object of the coil.

3365. Still, if you use the coil for the inner tube of the gun, you do not get over that difficulty, because you have got welds there in the dangerous place?—Not in the direction of the length.

3366. That is the advantage of the steel barrel?—I should say that is one advantage, not an important one.

3367. (*Colonel Simmons.*) In the 12-pounders you depend entirely on the steel for its strength?—From the trunnions forwards.

3368. (*Mr. Pole.*) Is there any important longitudinal strain on the barrel alone?—Not important on the barrel alone.

3369. But I suppose taking one of these guns in which the chase has entirely a steel barrel, when the shot has passed the commencement of the chase, the pressure is very much reduced?—Very much reduced in the 12-pounders. In fact, the pressure in the 12-pounders is trifling, comparatively speaking.

3370. (*Colonel Simmons.*) Do you find that the steel is acted upon more speedily by powder than wrought iron?—I think so, triflingly. It is always asserted to be so; and as far as our own experience goes it is so, with this one exception, that where little defective welds exist in the wrought iron the gas will eat them out considerably faster than if steel were there. It is the high pressure.

3371. (*Mr. McDonald.*) Will this mild steel weld well?—It will weld, but not well.

3372. Can you express in the same way as you have done with reference to the wrought iron, the loss at the weld in steel?—Yes. I should explain that I am merely stating these things from memory, and therefore it must only be taken for what it is worth, as to the loss at the weld. I cannot speak as to the steel, but I should say that the strength of the weld would be considerably less than in the case of wrought iron.

3373. It would be a worse weld?—It would be a worse weld.

(*Mr. Pole.*) It is a notorious thing, the difficulty of working steel.

3374. (*Colonel Simmons.*) Is there any special means applied for tempering these steel barrels?—Yes, we have tempered 12-pounders. We have not tempered the largest barrels; we have tempered 12-pounders according to a process of our own, in oil.

3375. All the 12-pounders are tempered in oil?—All the 12-pounders are tempered in oil.

3376. There is no special tempering process applied to them before they come to you?—No.

3377. What description of moulds are they cast in, in metal or sand?—In metal moulds, I think.

3378. (*Mr. McDonald.*) Is it the large barrels that are not tempered?—Some of our large barrels we do not temper. The masses are inconveniently large for tempering, and besides the effect of tempering is very questionable upon very large masses of steel. It puts on some uneven contractions, which would be very risky.

3379. (*Colonel Simmons.*) Is that tempering process which you have described applied to the 12-pounders and other guns of moderate size, after the barrels are bored and turned?—Yes.

3380. In fact, at the moment just previous to the "coil jacket" being put upon them?—Precisely.

3381. (*Mr. McDonald.*) With reference to the steel barrels which we have had under trial, have any of them any welds in them at all?—No.

3382. The advantage is that you do away with the necessity for welding altogether?—Precisely.

3383. (*Colonel Simmons.*) Then do you apply the tests you described previously to the steel, after it has been tempered?—Both before and after.

3384. And do you find a great difference in them?—Yes.

3385. (*Mr. Pole.*) Tempered steel is tempered steel, of course?—Yes, harder and tougher.

3386. (*Colonel Simmons.*) In each case it is applied after the barrel is bored and turned?—No; we cut discs off, as I described, before turning; and some we treat in a soft state, and some in a hardened state.

3387. Have you any objection to describe the tempering process that you apply, or is it a secret?—Oh, no! it is no secret; it is mere management. The men who are accustomed to it can tell by the temperature of the steel when to apply it. Generally, if the steel is of a little higher temper than usual the heat of the steel before tempering is not made so high, but it is just lifted up in that state when it is in a condition of uniform heat, and then dropped into the oil.

3388. Cold or boiling oil?—Cold, or lukewarm.

3389. The process of raising the temperature to which the steel is raised is not determined by measurement, but merely by the workman's knowledge of the material?—By the workman's knowledge of the material. Then we occasionally "bring back" the steel a little.

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3390. (*Captain Wilson.*) Reduce its temperature do you mean, or what?—Yes. You can tell the different heats to which you bring steel by the color of the surface; and we see from the knowledge of the subject that it should be brought back to a yellow or brown, or blue colour.

3391. To a certain colour?—Yes.

3392. (*Colonel Simmons.*) Have you tested at all by thermometers the temperature to which you bring the steel?—We have tested it in a way of our own.

3393. Can you tell us the temperature to which you raise the steel?—It depends upon the quality of the steel: to 800, 1,000, 1,100, it is easy to measure them according to our process.

3394. By expansion?—No.

3395. (*Mr. McDonald.*) Supposing large masses of steel, if you could temper them without any drawbacks, you would wish to do so. You consider it a disadvantage that you are not able to use the tempering process for the large sizes. Do you understand my question?—I understand your question, but I was thinking upon the answer. The fact is simply this, that I believe the evils of tempering in large masses are greater than any advantage to be derived from the process. I hope you understand what I mean.

3396. (*Colonel Simmons.*) What do you define as a large mass?—A 600-pounder barrel, or a 300-pounder barrel.

3397. Should you find any difficulty in tempering a 150-pounder barrel?—We have tempered up to 150, but not generally.

3398. 70-pounders you always do?—Yes. If we find a rather higher class of steel than usual we would not temper it. For example: shot of a certain size it is perfectly easy to temper, and you derive great advantage from tempering them; but if we get a 600-pounder shot and temper it, it is very liable to crack in the tempering; and not only so, but if you fired that tempered shot against a plate there exists such tension in the mass that it is almost sure to fly.

3399. By "fly," you mean break up?—Yes.

3400. (*Mr. Pole.*) Is not it the fact sometimes, that in tempering large barrels they may get crooked?—Oh, yes; they may get twisted; that denotes a certain want of homogeneity in the steel.

3401. I suppose you are compelled to temper after boring, otherwise your tools would not bore it?—It would be difficult, no doubt; but we could with this mild steel. We have had to do so sometimes a little; but it is difficult work.

3402. Do you give your barrels a parallel form externally, or are they slightly conical?—I think they are parallel; but these are details that I am not quite sure of.

3403. All Mr. Whitworth's are made conical; I do not know about yours?—I think there is a slight taper upon the fore part of them; I am really not sure.

3404. Do you find great additional expense in boring and preparing the steel as compared with the wrought iron?—Yes.

3405. Can you give any idea of the additional expense?—In the first place, in the coil barrel you have not to bore out of the solid at all; but, in the case of the steel barrel, you have very hard work to drill them, not with regard to the 12-pounders, there is no difficulty in them because it is a manageable size, but when you get above that it is very difficult.

3406. (*Mr. McDonald.*) But do not they get steel in cylinders?—Sometimes.

3407. Then that objection would not apply?—No.

3408. I understand that your barrels are all obtained solid?—Yes.

3409. (*Col. Simmons.*) Then if I understand rightly the cost of 70*l.* per ton for light guns and 120*l.* per ton for heavy guns for the steel, does not represent all the increased cost due to the steel?—No.

3410. Can you give any idea what additional amount per ton, as compared with wrought iron, might be considered to be put upon the steel in con-

sequence of the difficulty and expense of its turning and boring, and the other operations performed upon it?—It depends so very much upon what one puts on it for depreciation; whether you include simply workmanship or the value of machinery, depreciation of plant, and all those things.

3411. The question which the Committee are anxious to get at is the cost of these guns. Supposing the Government were to undertake to adopt either Sir William Armstrong's system or Mr. Whitworth's system, what we want is the relative cost of those guns. Of course, a very large item in that is the workmanship applied to the steel; and, of course, the object of asking Sir William Armstrong and Mr. Whitworth to attend to-day was to give us, as far as possible, all the details of the items which tend to make up the cost of these guns. Therefore, any facts you can give us as to expense are important?—It would be about 50 per cent. above the cost of the ingot.

3412. The cost of the ingot as delivered, and not what remains of it in the gun?—No; the cost of the ingot as delivered. Add 50 per cent. to that, and I should say that is about the cost of the steel barrel.

3413. Of the workmanship?—The workmanship and machine turning.

3414. Then, for instance, to exhibit what you intend to convey to the Committee, supposing we take the cost of the 12-pounder ingot at 70*l.* per ton.

(*Mr. Pole.*) Excuse me, I wish to avoid a mistake which I think you are falling into.

(*Col. Simmons.*) I think Captain Noble will give it us in this form:—he stated first of all that the ingot cost 70*l.* per ton, or thereabouts—the ingots for the 12-pounder—he only gave it approximately. Well, then, will he go on to describe to us what cost he will have to put upon that in order to get the value per ton of the steel that remains within the gun at the time of its completion.

(*Mr. Pole.*) That is quite clear, but he did not understand it so.

(*The Witness.*) I was giving you the increased cost of the barrel, as manufactured.

3415. (*Mr. Pole.*) Not per ton?—No; per barrel.

3416. (*Col. Simmons.*) How are we to get at it per barrel from the price per ton?—Take this barrel as costing 35*l.* as delivered from the maker; then it would cost about 52*l.*

3417. When complete and ready to put into the gun?—Yes.

3418. Then the ingots, instead of costing from 70*l.* to 120*l.*, appear to cost at this increased rate from 87*l.*, if the 12-pounder is the lightest, to 120*l.* You do not get any as low as 70*l.*?—No; not as a finished barrel.

3419. No; but as an ingot. In this calculation which you have just given us you state that the steel as delivered from the factory would cost 35*l.* for a barrel, which would be at the rate of 87*l.* per ton?—No; I think it would weigh more than 8 cwt., probably 10 cwt.; there are pieces to come off each end.

3420. (*Mr. Pole.*) You are more sure about the price per ton than about the weight?—I am more sure about the price per ton. But they are making at Woolwich now guns exactly in the way in which we are constructing guns, and you can ascertain all the costs from them.

3421. (*Mr. McDonald.*) You say they are making guns at Woolwich exactly in this way?—Yes.

3422. (*Col. Simmons.*) Have they the same tests and operations for tempering as you have?—Generally.

3423. (*Mr. McDonald.*) Are they 12-pounders?—No; I am speaking of the large guns. I do not know what they are doing with 12-pounders. I know they are making these large guns in our way.

3424. Then in point of fact they have adopted the use of steel with all its expensiveness?—Yes, as we have.



3425. (*Col. Simmons.*) Does that proportion of 35*l.* to 52*l.* which you have given us for the 12-pounder hold good with regard to guns of large calibre, or is it increased?—I should think so; but it is a thing that one cannot speak positively about. The enormous number of things that have to be taken into consideration before you can state what a thing does cost exactly make it very difficult. We can, of course, define what we make guns at, and all that sort of thing.

3426. What does that 52*l.* include?—I must state again that I am only giving a guess upon the spur of the moment; for nobody can pretend to state exactly what a thing of this kind does cost. I intended it to include simply the labour of boring it and the charges for the machines which do bore it.

3427. Do those charges include depreciation and all costs that the manufacturer would put upon the article before selling it.—Yes, I intended it to. But, in fact, it is hardly necessary to go into all these details in order to arrive at a relative cost; for it is, of course, evident that Sir William Armstrong's construction must be very much cheaper than Mr. Whitworth's. In consequence of their being both built-up guns there is no very great difference in the building up; whereas the cost of Mr. Whitworth's material is, of course, very much larger than Sir William Armstrong's; therefore, to arrive at the relative cost of the two guns, you have only to compare the different materials. The workmanship to be put on the material must be much the same in both cases. Both Sir William Armstrong's and Mr. Whitworth's are built-up guns.

3428. (*Mr. McDonald.*) I suppose that is a matter that Mr. Whitworth can state for himself?—He does not dispute that they are built up.

3429. Yes; but he will probably dispute that they are dearer?—There can be no dispute about it. You have only to compare the two prices.

3430. (*Col. Simmons.*) There is some difference between the shunt and the breech-loader with regard to the manufacture?—They come to the same price, because the breech-loader is the lighter gun.

3431. (*Mr. Pole.*) Lighter?—Yes, some 15 cwt. lighter.

3432. (*Capt. Wilson.*) Could you not give the Committee some precise information relative to the cost of these guns founded upon what you have charged to foreign Governments?—I could.

3433. I mean it would be in your power to obtain and furnish information of that kind?—I could give it, but you have our contract prices with the British Government.

3434. For those guns which you supplied?—They are not quite the same, but you have only to estimate and add the actual amount of the extra cost of the steel barrel.

3435. But I think they would expect us to get precise information for them; therefore I ask you to give it?—The question is, in what quantities are we to suppose these guns are wanted? I have got a list here of these guns.

3436. Have you supplied them in numbers?—Yes.

3437. (*Col. Simmons.*) What is the cost there given as to the 12-pounder breech-loader and the 12-pounder shunt gun?

(*Capt. Wilson.*) I asked the question because in the former sittings of the Committee, before I was a member, certain lists of guns and projectiles were handed in, but those were not the identical guns?—Yes, they are the identical guns.

3438. (*Col. Simmons.*) What was the cost of the 12-pounder given on that occasion?—90*l.* each.

3439. What has been the actual cost of the 12-pounder breech-loader, as delivered, and of the 12-pounder muzzle-loader shunt gun?—254*l.* for the breech-loader and 226*l.* for the other.

3440. It is put here; 3 breech-loaders, 254*l.* each.

3441. (*Mr. McDonald.*) Is 254*l.* for the breech-loader?—Yes; and 226*l.* for the shunt.

3442. (*Col. Simmons.*) May we take these prices of the guns as delivered to the Committee as a fair average price what the Government would have to pay for a large number of guns?—Oh, no! not a third of it.

3443. That is what I want to arrive at.

(*Col. Ormsby.*) The easiest way would be to ask Sir William Armstrong and Mr. Whitworth what they would supply them to Government at per thousand?—No; that is no test. But I happen to know in one case both Mr. Whitworth's prices and our own, and I know, for example, that Mr. Whitworth asks 3,000*l.* for a 300-pounder, and our price was 1,620*l.* for the same gun. That I happen to know from very good information. But it stands to reason, if you use a more expensive material, there not being a great deal of difference upon the workmanship, if you use a material costing 80*l.* in the rough state, instead of a material costing 20*l.* in the rough state, it stands to reason that the gun cannot be so cheap. There is no escape from the conclusion.

3444. (*Col. Simmons.*) Are these prices you have just given prices of experimental guns or prices of guns for foreign countries, large contracts?—No; I am not sure whether Mr. Whitworth's gun was for two or for four; but ours was only for four.

3445. (*Mr. McDonald.*) Where they to be of the same size?—The same weight. His was to be a 9-inch, I believe, and ours a 10-inch.

3446. (*Col. Simmons.*) The same weight of gun or of shot?—The same weight of gun within a very small amount.

3447. And of projectile?—About the same.

3448. (*Capt. Wilson.*) Then these prices you have named are merely prices of experimental guns?—No.

3449. (*Capt. Wilson.*) And will not throw any light upon the actual cost of a contract?

(*Mr. McDonald.*) I wanted to put some questions upon the cost of the coil. To what extent does that add to the value of the raw material, the processes connected with the coiling, the rolling of the iron and the turning?—I am talking of the iron in the rolled form. The iron comes to us in the rolled form at 20*l.* per ton. We get the bars rolled and then we coil them.

3450. Of course you get the bars rolled, but I used the word "rolling" with reference to the coiling. What I wanted to know was how much the treatment which the wrought iron receives after you get it in order to get it into the coiled form and to weld it, and all that sort of thing, how much that adds to the cost of the wrought iron?—I shall be making a very liberal estimate if I suppose the coiling and welding of the coil increases the price to 30*l.* per ton.

3451. (*Col. Simmons.*) Do you mean the actual coiling or the cost of the iron when coiled including everything?—The cost of the iron when coiled including everything.

3452. Turning and all?—Not turning; because the steel will have to be turned afterwards. In that state you may take the two things as being analogous. Both the steel and the coil will have to be bored and turned, and therefore the cost will be about the same. If anything the steel will be the more expensive because it will be a slower process.

3453. (*Mr. McDonald.*) What would be the cost of the wrought iron?—About 20*l.* per ton.

3454. So that the wrought iron portion of the construction with the cost of coiling and welding added, comes to about 50*l.* per ton?—30*l.* I said 50 per cent. on the 20*l.*, which makes 30*l.* per ton.

3455. I misunderstood you. I thought you said that the cost of the coiling and welding added 30*l.* to the price of the iron?—I said it added 50 per cent. to the 20*l.*, making a total of 30*l.*

3456. (*Col. Simmons.*) In fact it so happens that the cost of workmanship both of the steel and of the iron may be taken as 50 per cent. in addition to the raw material. In the case of the steel, you went from 35*l.* up to 52*l.*; in this case from 20*l.* up to 30*l.*. In each case it would appear to be about the same relative proportion?—I do not understand. We have not had

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any analogous process. The proposition I lay down is this, and for the sake of simplicity I will leave out of the question the process of coiling, merely saying that the coils, when ready for the machine, are worth about 30*l.* per ton. Then I say the steel rings, if we adopt that process, when delivered to us, would not be delivered below 80*l.* per ton. You therefore have these two things, a hoop of steel and a hoop of wrought iron, and both of them have the same processes applied to them. What I say is, the cost of the coiled iron is 30*l.* per ton and the cost of the steel hoop is 80*l.* per ton. Therefore I say that a gun made in the external parts of coil, do what you will, must be very much cheaper than a gun made with similar parts of steel. In our opinion, and we maintain that it is upheld by experience both in this country and abroad, and upheld by Mr. Whitworth's experience as well as our own, the coil is very much superior to steel for this purpose.

3457. (*Mr. Pole.*) Then I understand, I think, that the iron, as you get it from the manufacturers, the bar iron from which you make the coil costs about 20*l.* per ton?—Yes; but I ought to state that in the gun factories just now they are using for these coils a very much cheaper iron, perhaps a 14*l.* or 12*l.* a iron. We are not prepared to do that yet; but of course we are at liberty to go into the market. But we will see first what the Government makes out of the cheaper iron. And if it be found that this cheaper iron answers reasonably well, it would, to a very great extent, diminish the cost of the coil gun.

3458. What is the cost of the best locomotive bar iron, the best Yorkshire iron, about 16*l.* is it not?—I should think it is up to 20*l.* rolled. Any how, we put into the gun the very best iron we can get.

3459. (*Mr. McDonald.*) Do you think it a matter of importance that you should have the best?—Yes; but if the Government find that the cheaper iron will do well, we will follow. But we put in the best for the same reason that railway engineers will always specify for Low Moor or Bowling iron to be put into locomotive tires.

3460. Is it not because you consider it necessary?—Yes, because there is a saving, it welds better.

3461. Supposing steel to be proved better than iron?—It is not.

3462. As I understand you consider the very best wrought iron requisite for the outside of the gun, you go on and pay the best price for that and think it of importance to have it?—Yes, at present.

3463. You have got reasons for having that strength and that quality there?—It is worth the makers while to make that iron of perfectly uniform quality. We pay a good price for it. We reject any bars that have the least defect in them; the makers get a price, which in fact makes it worth their while to give us the best quality, and we do get it. If we were to fight them for 10*s.* a ton we could not get such an article. From long experience with guns we can put this iron into our guns with very great safety. For one or two of the outer coils I have no doubt a cheaper iron might be adopted.

3464. You consider on the whole that the very best iron you can get is desirable for that purpose?—Yes.

3465. Supposing it turned out that steel were better?—If so, and the price we could get it at was such as would make it worth while to make the change, that is to say, if the additional advantage was such that it was worth while to apply steel, of course steel would be applied.

3466. Do you consider that it is possible that steel would be better than the iron?—It is possible that it might be; but all experience goes against it. Mr. Whitworth's as well as our own.

3467. Supposing Mr. Whitworth should say different?—Well, but then there are the facts.

3468. Every body knows his own experience best. You do not know Mr. Whitworth's experience?—I know a good deal of it. I suppose you are aware that out of four of the steel guns that Mr. Whitworth supplied to His Highness, the Viceroy of Egypt, the

whole four failed, two in proof and two in practice. The Chief of the Egyptian Artillery is in the country and would be able to furnish the particulars to this Committee if they wished it. Then Mr. Whitworth also supplied some steel guns to the Government at Copenhagen which failed, and did considerable damage.

3469. (*Col. Simmons.*) When were these guns supplied?—I do not know exactly. I merely state the fact as corroborative of what I have said.

3470. (*Mr. McDonald.*) I suppose Sir William Armstrong had his failures when he was experimenting about these matters?—Yes; but he never put steel into guns until he was quite sure, and the consequence has been that there never was a life lost by his guns, whereas there have been several lost by those instances I have mentioned above.

3471. (*Mr. Pole.*) Did you ever know of an instance of the coil gun bursting and killing anybody?—Never.

3472. (*Mr. McDonald.*) As far as the coil for the interior of the gun is concerned it is abandoned?—I am not at all certain if we could get iron that would weld perfectly and that was sufficiently hard, that we should not prefer a coiled barrel. I believe in the Royal Gun Factories they are making efforts to retain the coil barrel. They find the uncertainty of the steel so great. I am speaking in this respect merely from hearsay.

3473. Then the Committee is not entitled to draw the conclusion from the guns which they have got now, that steel has finally taken the place of wrought iron for the interior of guns?—I think not. It is impossible to say what future improvements Sir William Armstrong or Mr. Whitworth may make. The guns which the Committee have before them as far as regards Sir William Armstrong are what he considers to be the best he can at present produce. Beyond that it would not be right for me to state anything.

3474. (*Major-Gen. Taylor.*) With the present knowledge of the manufacture?—With the present knowledge of the manufacture.

3475. (*Col. Ormsby.*) Have you not got two sorts of guns before you?—You have, with regard to the 70-pounder breech-loader, a coiled gun and two steel barrels. But I ought to explain with regard to that, the Government pressed upon Sir William Armstrong that these guns were to be ready in three months. He had them ready by that time; but to do that he abstracted for this trial a gun from a lot that was being made for the Government. He took this coiled gun because he thought there might have been some difficulty in finishing within the time. But, as you know, the trial, instead of being in three months, did not come off for 15 months. These guns were lying at Elswick all that time, and it altogether escaped his memory that that was a coiled gun, or he would have made a steel barrel to replace it.

3476. With reference to the last question before this, do you say that the best that can be made are coiled guns or steel barrels?—At this moment Sir William would supply a steel barrel instead of a coil.

3477. (*Mr. McDonald.*) But he does not finally say that a wrought-iron barrel may not ultimately prove the best thing?—It may ultimately prove the best thing.

3478. You look forward with hope to its doing so?—I do not much care which way it is. We shall, of course, use whichever is the better.

3479. (*Col. Simmons.*) We may consider with regard to the 70-pounder, that the steel barrel is the exponent of the best gun according to Sir William Armstrong's experience at the present time?

(*Mr. Pole.*) You would not bind yourself to the future, but you would take advantage of whatever improvements in manufacturing may turn up?—Just so.

3480. (*Mr. McDonald.*) You do not suppose there is any anomaly in strengthening a material like steel with a material which is weaker in itself?—It is stronger to resist percussive action, but it has not so high a tensile strength. If the Committee will allow



me, I will relate an experiment which was made, and which shows the peculiarity of the steel to which we have been referring in my evidence.

3481. (*The President.*) About what year was that made in?—About the middle of 1862 we made a plate of steel, and, by tempering it in a peculiar manner, got a very great deal of toughness. We cut bars from this plate and tested them in a variety of ways; we found that it would bend a great deal more without cracking or fracture than we could get wrought iron to do. Afterwards, on firing at the very plate from which the test pieces had been cut, we found that the steel plate broke up with long glassy fractures.

3482. (*Captain Wilson.*) Starred?—Yes, while the wrought-iron plate which was compared with it resisted the action of the shot perfectly.

3483. (*Mr. Pole.*) Do you not know it for a fact that one of the most marked results of the four years' trials of the Armour Plate Committee was the total unfitness of steel for armour plates on that account; its total inferiority to iron on the ground of its being unable to resist sudden blows, on the ground of its cracking and failing to stand with the yielding capabilities that iron always has?—I know that to be a fact, and it is precisely for that reason that Sir William Armstrong objects to its use in ordnance.

3484. (*Mr. McDonald.*) I wanted to ask whether the strain that hoops are subjected to is not mainly tensile strain?—Yes; but it is a tensile strain applied so rapidly as to be percussive.

3485. Then does tensile strain become convertible into the other strain at a point?—It is rather difficult to define. There is no real difference in the force, it is only that we are unable to assign the laws of percussive force. We can judge of the percussive force by the effect on the object which it produces; but we cannot say the law by which it has acted in the way that we can with regard to some other forces.

3486. Then probably the correct answer would be that it has not a tensile strength but a percussive strength, would that satisfy you?—No; it would not satisfy me. I am really unable to enter into this point without considering my answers. The subject would require so much scientific explanation that I could not trust myself to go into it upon cross-examination without preparation.

3487. Suppose it turned out that wrought iron, I merely raise the question as a supposition, that wrought iron be inferior in tensile strength when applied to hooping and show this inferiority, and that it became desirable to have the best tensile strength material, what material would you use?—If we found to be a fact that which is not a fact, we should of course adopt the steel.

3488. What is not a fact?—It is not a fact that the steel is better under the peculiar strain which acts upon it in guns than wrought iron.

3489. What is the peculiar strain?—It is this percussive strain to which I have alluded; the liability of steel under that strain to crack and go into those glassy fractures.

3490. Then, if I understand, you withdraw the word "tensile" and use the word "percussive," as applied to the strain?—I will, if you like. I have no objection.

3491. (*Mr. McDonald.*) I merely want to have the point cleared up.—Yes! I see what you are driving at.

3492. (*Mr. Pole.*) Is it not notorious among persons who have used iron, that tensile strength is no test of fitness to stand percussive strain?—It is.

3493. Is it not well known that some iron which for that purpose is the very worst, has shown itself to be of the best tensile strength. Do you know that Mr. Kirkaldy found that some iron having the highest tensile strength was the worst iron to stand percussive force?—I wish to point out that I have inadvertently used the word "tensile" in two different meanings. When Mr. McDonald asked me a question as to the strain of the iron being tensile, I merely meant that it was applied in the direction of the

length; that is to say, in the direction of drawing it asunder. I do not mean that the strain was of the nature of a tensile strain as we apply it in the testing machine; but merely that the strain was tending to pull the coil asunder. That was all I meant when I used the word tensile in that sense.

3494. Do you not know that in the case of the "Royal Charter," which went to pieces because the iron could not stand the blows upon the rock, it was shown when the iron was tested that it was of very great tenacity?—I have no doubt of it.

3495. And that common boat plates which are quite unfit to make good and durable vessels often show accidentally very large tenacity?—Yes; and I think the iron you use for plates does not show very high tensile strength.

3496. (*Col. Simmons.*) Do you consider that you can compare properly the action of the gunpowder upon the gun within the gun, with a hard projectile striking an iron plate?—To some extent.

3497. (*Mr. Pole.*) Do you not consider that they both come under the definition of strain suddenly applied?—They both do.

3498. It is sudden application of strain which forms the test for these purposes?—Yes.

3499. (*Col. Simmons.*) The strain as applied by a projectile striking a plate is applied over a very limited surface, whereas the strain within the gun is applied over the whole surface of that part of the bore which is exposed to the action of the powder?—Yes; and that is a very small surface. In this gun [*pointing out the same on the drawing*] the maximum of pressure is when the projectile is about there [*pointing*]. It is applied suddenly and percussively.

3500. In the other case, when the projectile strikes the plate, the first action of the blow is carried off by that portion of iron only which corresponds with the size of the projectile; I mean if a circular projectile strike a plate, a portion of the iron corresponding with the circumference of the circle only has to bear the strain.

3501. (*Mr. McDonald.*) Supposing it to be of importance to have the best material outside the gun to stand percussive strain, it would be a question of course between steel and wrought iron?—I do not quite take the meaning of your question.

3502. Supposing it to be of importance to have outside a gun the best material known for withstanding a percussive strain, using the term in your sense, suppose it would be a question between best wrought iron and steel?—No, I do not think so. I should put inferior wrought iron before steel.

3503. You would rather go down to lower qualities than up to higher?—I would rather go down to lower qualities than to a different material which I do not consider so well adapted.

3504. Then you do not consider it of importance, in a mechanical point of view, to have a material like steel strengthened by a material at least as strong as itself?—No, I do not.

3505. Then you do not consider it of importance to add to the strength of the gun by the hoop; you would use the hoop mainly for the question of safety in case of rupturing the inner barrel?—No hoop will prevent the inner barrel from rupturing.

3506. The stronger the hoop is, the stronger the gun would be?—Clearly.

3507. (*Col. Simmons.*) I suppose the question of the weight of the gun enters with this question of employing good or less good materials in the external coil. If it was an object with you to get your gun very light you would use the very best materials; you would make up for any deficiency in the quality of the material by adding to the weight of the gun?

(*Mr. Pole.*) Do you think the gun would be equally safe reducing the coil because the tensile strength of your metal was greater; do you think it would make the gun as safe as the other plan. Supposing you had two guns one with a thick coil of iron and

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another with a thin coil of steel placed over, because the iron has less tensile strength than the steel, which do you think would be the safer gun? The object of my question is to test the former hypothesis that you might reduce the coil by using a material of higher tensile strength; that you would use a thinner coil of steel because its tensile strength is higher; do you think a thinner outside coil of steel would make a safer gun?

(*Col. Simmons.*) I had in my mind two coils, two descriptions of wrought iron.—My meaning was that if you applied an inferior wrought iron you could make up for using that inferior wrought iron by putting in greater weight.

3508. (*Col. Simmons.*) That is my meaning; but to carry on the analogy still further perhaps you had better answer Mr. Pole's question; whether or not if you had steel of greater tensile strength, it would enable you to reduce the weight of the gun?—No; because I do not consider the steel, although under our testing machines it has higher tensile strength, stands the percussive action so well.

3509. (*Mr. Pole.*) Therefore the gun would not be so safe.—Therefore the gun would not be so safe.

3510. (*Mr. McDonald.*) May I ask you why, if steel is found to resist percussive action in the barrel, it should be found not to do so in the coils?—We do not depend upon that in the barrel, it is strengthened under pressure by the coils, and the principle of build-up the gun is such that the strain is taken by the outside of the gun as well as the inside. In fact so that the barrel will not burst until the outside coils go too.

3511. Then, as I understand, your present predilection for steel in the barrel has no reference to the superior tensile strength of the steel?—No.

3512. But is mainly founded upon the homogeneous quality of the steel, its freedom from welds?—Yes, and its greater hardness.

3513. (*Mr. Pole.*) Its capacity to resist wear?—It resists wear and it resists dents better.

(*Col. Simmons.*) May I go on with the question I was going to ask, or are there any more questions to be asked upon this point?

3514. (*Major-General Taylor.*) There are one or two questions I should like to ask while we are upon this matter. Do you not imagine that a greater amount of accurate knowledge can be obtained with respect to the qualities of these different metals on a small scale as compared with a large one.—Yes.

3515. Do you think if there were clearly established merits attributable to the use of steel that the gun manufacturers would, by this time at all events, have experimented upon that to some extent?—Yes.

3516. Do you know of any instance in which they have failed?—Yes, from many sources.

3517. What has been the result as far as your knowledge goes?—As far as my knowledge goes one and all are giving up the use of steel in the solid form. I am informed that the Russian Government have been compelled to abandon solid steel guns, and I believe they have thrown up their original contract with Krupp and are trying different plans. I can also speak to the cases I have alluded to, the Egyptian and Danish experience and the American experience. In fact everybody, one and all, that I have seen upon the point have said that steel so far has been a failure in large masses, and a failure even as Krupp applied it, to building up a large barrel of steel and then putting a layer of steel coils over it.

3518. Then in fact we may take it for granted you are enabled to state from your own knowledge of the present manufacture of guns of that description that they adhere to the coiled system, to the twisted barrels, or are there any barrels that are solid forgings bored out, used in the manufacture of guns of that description?—There are some used by foreign countries but they are not liked. I believe the Americans are trying their hands at coils.

3519. (*Mr. McDonald.*) The Parrott gun has a coiled jacket?—Yes.

3520. The one that burst the other day?—Yes, and that burst with us so largely, a coiled jacket on cast iron.

3521. Allow me to call your attention to some of the points which that raises. I suppose you attribute the bursting of the gun to the cast-iron tubes.—Clearly. We have had cast-iron broken up within the coil.

3522. Then it is a matter of the more importance to have a strong material for the tube?—For the tube, undoubtedly.

3523. But the strength of the steel of the tube is not a consideration with you; it is the hardness and the absence of the welds?—Yes; but you cannot consider cast-iron hooped as a built-up gun at all, you simply put a coil on the outside. The fact of the matter is, that we have found our own cast-iron guns burst equally whether you put the coils on or not.

3524. A cast-iron gun with the coiled jacket remains a cast-iron gun; but the steel gun with the wrought-iron jacket is a wrought-iron gun?—There is no resemblance in the construction of the guns that you are comparing.

3525. I want to draw your attention to this.—I see exactly, but my point is this; the cast-iron gun to which you refer has no property of a built-up gun.

3526. (*Col. Simmons.*) In reply to General Taylor, you said just now that the Russian and other governments abandoned the employment of steel in the manufacture of their guns; but do you consider the manufacture of steel has arrived at that state that you can give it as your opinion that steel will not be so improved that eventually it might not supersede wrought-iron, setting aside the question of coil?—That it is a possibility I do not deny. I do not at all mean to say that it is altogether out of the question.

3527. Guns were formerly made of wrought iron, and then it was abandoned, and it has only been re-introduced in consequence of the great improvements in the manufacture of iron within the last ten years; query, why should not steel become in the same position?—No solid wrought-iron large guns have been made in large quantities; and for this reason, that, the very defects which exist in the cast-iron homogeneous gun exist equally in wrought-iron homogeneous guns or in steel homogeneous guns. The outer layers do not add to the strength when you pass a certain limit, or they add in a very trifling degree. You are, of course, fully aware of this.

3528. (*Mr. Pole.*) Everybody knows Mallet's investigations?—Wrought iron would be better than cast iron because the constant, so to speak, is high. That is the reason why we may expect the wrought-iron guns to last to a certain extent better than cast iron, and steel better than iron, but they both have the defect alluded to, viz., that the outer layers add but little to the strength.

3529. (*Col. Simmons.*) You mean guns made in one piece?—Yes.

3530. (*Mr. McDonald.*) Then you consider it of importance to have the element of strength carefully preserved in the outer portion of the gun?—Clearly. Of course, should a process be discovered by which steel could be made better than wrought iron under those circumstances it would be adopted, provided the cost were not prohibitory.

3531. With reference to the question of cheapness and dearthness and durability, that is a matter which you would consider fairly an element in the calculation?—Clearly.

3532. Supposing a gun to be made which would last two or three times longer than another gun, and that it was, say as dear again, you would consider that the cheaper gun of the two?—Well, that is rather a question for an actuary to go into, a question of the value of money.

3533. Still it is a matter which lies in a narrow compass, within certain limits?—Clearly.



3534. It is an economical question?—Precisely, but I cannot give an answer to it on the spot. There are plenty of Armstrong guns in the service from which have been fired 4,000 or 5,000 rounds; am I right?

3535. (*Major-Gen. Taylor.*) 3,800 was the largest number fired?—It is no doubt a question, supposing the guns are compared, how much you are to pay for the quality of endurance.

3536. (*Mr. McDonald.*) The old cast-iron gun stood, we will say 1,000 rounds?—It is found that the average of the 68-pounder was under 400 rounds.

3537. We will take the Armstrong service gun, and we will say it stands 4,000 rounds: well, I do not know what the price of the one is as compared with the price of the other, but we will suppose the Armstrong gun is twice as dear as the cast-iron gun, would you as a man of business have any hesitation in saying that the Armstrong is a great deal cheaper gun in reality than the other?—I should if the efficiency were the same. I should have great hesitation in recommending the more expensive gun, but the large Armstrong or any rifled gun is much superior to the other in point of efficiency.

3538. Putting that out of the question, putting the question of efficiency out of the way altogether?—If I were Secretary of State for War I should give it my serious consideration before I bought the more expensive gun.

3539. (*Col. Simmons.*) I suppose your calculation would be somewhat influenced by the probable number of rounds which a gun would be required to fire upon service. If it were a theoretical question between 30,000 and 60,000 rounds, one would be just as valuable as the other?—Just so; you put it clearer than I did. It would depend upon many considerations of that sort.

3540. (*Mr. Pole.*) Do you think the substitution of steel coils for wrought-iron coils round the barrel would tend to give the gun a longer life: what part is it that goes by wear?—Only the barrel.

3541. Then the substitution of steel for iron coils would not affect the life of the gun?—No.

3542. (*Mr. McDonald.*) Supposing it turned out that the steel-coiled gun stood being fired at better than the other, was less susceptible of damage from being fired at than the gun with the wrought-iron coils, I suppose you would consider that an advantage?—A slight advantage if it were true, which I do not think it is. Merely putting it as a hypothesis, if it were so it would be an advantage, but it would not as a personal matter weigh much with me, because if either gun got a direct hit, I imagine it would be, at all events, temporarily disabled.

3543. If the two guns were precisely equal in every other respect?—Of course one would give weight to any advantage.

3544. (*Col. Simmons.*) Now, having gone so far, I will go back to the question I put to you before. Since I put that question the plans have arrived, and perhaps they might refresh your memory. [*The plans were placed before the Witness.*] I want to ask you, having brought the manufacture of your gun to the condition that you have your steel barrel prepared for the coiling, and having your coil prepared likewise, what is the price of casting the two together?—The gun itself is sunk in a pit; the coils themselves being likewise prepared are shrunk over it.

3545. The inside of those coils are turned?—Turned very carefully in every respect.

3546. And turned somewhat smaller?—Somewhat smaller.

3547. What is the proportion of expansion that you allow?—I cannot say; it varies for all guns. There is a certain amount of contraction; it is generally determined by experiment; it is easily obtainable.

3548. The object being to get a tensile strength upon the coils?—The object being to get a tensile strain upon the coils.

3549. To what degree of temperature do you bring those coils?—To what is called a dull red. *Captain Noble.*

3550. What may it be by the thermometer?—I think it comes up to 1,000° or 1,200°. *30 Jan. 1865.*

3551. The coil is then raised to a temperature of something about 1,000° or 1,200°?—Somewhere about 1,000° or 1,200°.

3552. That is shrunk over the coil?—Yes.

3553. Is not that process liable to affect the temper of the steel?—No; we never raise it up to a height that affects it.

3554. I think in a previous answer you said that the steel in order to temper it was raised to a temperature of 800° to 1,100°?—Yes.

3555. Is not the superimposing of the coil calculated to have some effect upon the temper of the steel?—It would have some effect, but not to a great extent; the steel is never raised to a yellow.

3556. That would depend on the mass?—Yes.

3557. Do you adopt any process to keep the steel cool internally?—Yes. There is a constant stream of water passing through it to keep the temperature down.

3558. So that probably the interior of the barrel is at a lower temperature than the other part?—Undoubtedly.

3559. Then you do not anticipate that there would be any change in the constitution of the steel effected by that?—I think not.

3560. Have you ever taken any of the barrels out that have been so treated, and tested portions of the steel taken from those barrels, and compared them in the experiments made upon the jackets before they were shrunk on the steel?—We have had it done, and we could not see that there was any material difference at all.

3561. Those experiments proved satisfactorily to you that you had not damaged the interior of the steel by the process of putting on the coils?—We have had no evidence of the barrels being at all injured.

3562. Mr. Whitworth, in his statement before the Committee at the early commencement of our investigation stated that he put on his coils by a process of hydraulic pressure without heating, and considered that there was great advantage derived therefrom, both in giving him a better knowledge of the strain he brought upon the metal; and I think also he said as not being liable to alter the temper of his steel in the same manner as the process of shrinking on the coils; do you consider there is anything in that?—I do not consider there is. Of course it is presumption in me to say so if he is satisfied with regard to his guns, but we have no such experience. Mr. Whitworth's mode is liable to another serious fault; his inner barrel often turns round. If you refer to General Gilmore's report he says the Parrott guns were superior to Whitworth's, from the fact of Mr. Whitworth's barrels turning round and thereby spiking themselves.

3563. Do you consider it necessary that the external surface of one coil and the external surface of the next that comes upon it, should be turned with as much accuracy when you shrink on as when it is forced on by hydraulic pressure?—We have no difficulty in turning our coils with extreme accuracy.

3564. Your turnings are all parallel?—Parallel, almost. We have some tapers, I think.

3565. Do you find any increased difficulty in tapering them so as to shrink one on to the other, as compared with the parallel?—No.

3566. (*Major-General Taylor.*) If you had two cylinders, identically uniform in every respect, and you were to find that on raising them to the same temperature one was to show an inequality of calibre, would you not assume either that a different heat had been applied to parts of that, or that there was some want of homogeneity in the metal itself?—Yes.

3567. (*Colonel Simmons.*) In the 12-pounder that you have, the breech-loader, how many different coils have been imposed on the steel barrel?—Four.

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3568. Would they require to be put on at four different times?—No, one after the other.

3569. So that the steel is not subjected to four heatings and coolings?—No.

3570. The same with regard to the muzzle-loader?—The same would apply to the muzzle-loader.

3571. (*Major-Gen. Taylor.*) That [pointing to the drawing] is the point where one coil over-laps the other. In shrinking these on, do you allow for that at this point where they pass, and close them afterwards by forging; or do you assume such exactitude of coil that you can introduce the second coil without any force?—They are put on, and the joints caulked. We do not depend, in the 12-pounders, upon the coils for longitudinal strength; but in the case of the 70-pounder, the coils are jump-welded together, and the second layer is put on in two pieces.

(*Major-Gen. Taylor.*) They are jump-welded before they are put on.

3572. (*Col. Simmons.*) The breech piece, in the 12-pounder muzzle-loader, is fixed in by a screw, is it not?—Yes; the breech screw, as we call it.

3573. Is that steel?—I am not sure. I think in that gun it is steel.

3574. What do you make them of in the 70-pounder?—They are wrought-iron in the 70-pounder.

3575. The breech screw?—Yes.

3576. With wrought-iron tapped into that steel screw?—In the 12-pounder.

3577. Not in the other?—No; it goes into the wrought-iron breech piece.

3578. (*Capt. Wilson.*) The plug is steel?—Yes.

3579. (*Col. Simmons.*) The 70-pounder gun is different from the 12-pounder, inasmuch as the super-imposed coils are formed into one mass, and put, in one mass, upon the steel barrel?—Yes.

3580. (*Major-Gen. Taylor.*) Is that always the same?—Yes, it is put on in two pieces.

3581. (*Mr. Pole.*) Is there not also the great difference of the addition of the forging which connects the breech with the trunnions to give it longitudinal strength? That, I understand, does not exist in the 12-pounder gun.—No; the steel goes right through in the 12-pounder.

3582. Will you explain the construction of that breech trunnion-piece in the forging? Does this which you state apply both to muzzle and breech-loading guns?—Yes; the coils are intended to resist the explosive force; but with regard to the breech-piece, the strain on it is lengthwise [explaining on the drawings]. Therefore the breech-piece is forged so as to have the strength of the iron running longitudinally [pointing]. Into that breech-piece forging the breech screw is screwed, and the breech-piece resists the tendency of the powder to blow out the breech screw. Everything else upon the gun is coil.

3583. (*Mr. Pole.*) It is, in fact, a means of conveying the strain from the breech to the trunnions longitudinally?—Exactly.

3584. How far does the breech forging extend?—It does not extend very far. It is not shown in this plan; it is somewhere about here [pointing].

3585. Is all this solid [pointing]?—No. These dotted lines show that the breech-piece is jump-welded on to the next coil.

3586. Are the guns at the Arsenal welded in the same way?—Exactly.

3587. (*Major-Gen. Taylor.*) This being inserted there, [pointing to the drawings,] what is the process by which that is put in?—It is first turned with very great care, exactly true; then it is covered with red marking, and put in; and then the marking shows whether it bears uniformly. Then, if it is wrong, it is altered. Then this piece of copper is put in here, [pointing to the drawing,] to act as a valve and prevent the passage of any gas.

3588. Do you contemplate this plug being removed, or being a permanent portion of the gun? Practically, can you abstract the breech-piece after the gun has been fired many times?—We have done it; we have taken it out several times.

3589. (*Capt. Singer.*) Not with the gun at Shoe-buryness?—No.

3590. (*Major-Gen. Taylor.*) Contemplating the deterioration of that pin after a great many rounds, is there any process by which you could, without sending it back to the factory, take it out?—We could either take it out, or, if it were rusted in, we could bore it out.

3591. Of course, *à tour de force*; but is the present arrangement such that you could remove this breech-screw and get actually into contact with the copper, and take that out and renew it?—Yes, it could be done; we have done it, in fact.

3592. (*Capt. Wilson.*) Without boring out?—Yes; that is quite possible.

3593. (*Col. Simmons.*) Then the extent, as far as I can understand it, that we have arrived at, as regards the cost of the Armstrong gun, is this,—that the steel, which costs from 70*l.* to 120*l.* a ton, has 50 per cent. added to it to make up the value of the steel in the barrel; and in the same way we may take the iron as prepared, before it is shrunk on, at 30*l.* a ton. Is that so?—If the Committee want to get at the cost of Sir William Armstrong's system, they are making this gun, as nearly as possible, in the Royal Arsenal, and the cost can be obtained from them. Or, again, you can find the exact price which we charged the Government for similar guns of wrought-iron, and to that price you can add the additional cost of the steel barrel, thus obtaining the cost of the gun as at present made.

3594. (*Mr. Pole.*) Taking a barrel which weighs about a ton?—I will take a 70-pounder barrel, which does weigh about a ton. That will cost about 70*l.* a ton, and therefore 70*l.* for the barrel. Then the expense of boring it, the labour, and various things, will be about 35*l.*, which makes the barrel cost about 105*l.* Then the barrel itself, when it is finished, will only weigh, say, half a ton, when it is bored out and finished; therefore the cost of the finished barrel per ton will be 210*l.*, which is three times the cost per ton of the raw material.

The Committee then adjourned for a short time.

3595. (*Capt. Singer.*) Do I understand you to state this as your own and Sir William Armstrong's opinion, that the cost of the guns will vary very nearly directly with the cost of the material?—Yes.

3596. Do you consider that to be Sir William Armstrong's opinion also?—Well, approximately; there is the labour.

3597. As the same amount of labour would be expended on each gun, no matter what material, they will vary, really, directly with the cost of the material?—Yes.

3598. (*Col. Simmons.*) Then I should like to ask Captain Noble a question. Do you consider that the cost of labour upon the two different materials would follow the same proportions as the relative cost of the material? Before you can consider the mere weight of the guns and the relative cost of the materials, and so get at the comparative cost of the two guns, you must take into consideration the element of labour?—The only way I can see to arrive at the cost is this. We are making guns just now, and I can tell you, if you will extract the same information from Mr. Whitworth, what we are making them for.

3599. (*Mr. Pole.*) What sort of guns, and how will that bear on our inquiry?—I will give you the lists. If you will get from Mr. Whitworth a *bonâ fide* statement of the cost at which he is making, and what he is making, I shall be ready to show ours.

3600. You will be content to rest the comparative cost of the guns of the two systems upon the contract prices for which you and Mr. Whitworth are making for foreign Governments?—I should not be content to do so, but that seems to be the only way in which the Committee can come to any practical conclusion.

3601. (*Col. Simmons.*) And those prices which you can give in that way, do they comprise both light guns and heavy guns?—Yes, everything.



3602. Up to what calibre do they go?—To the 600-pounder. We are making 600's, 300's, 150's, 70's, 40's, 20's, 12's, 9's, and 6-prs.

3603. (*Mr. Pole.*) Don't you think the Committee should have some means of verifying the prices?—I can only refer to one or two persons in this country, and you can get the prices from them.

3604. It is not a matter of doubting you, but as a matter of business; it would be well for the Committee to certify of their own knowledge that such were the prices?—I can give you the names of one or two of the foreign Ambassadors, who, if applied to by the English Government, would, I have no doubt, give our prices. It would save us from the suspicion of false faith.

3605. (*Col. Simmons.*) Do you supply shunt guns or breech-loaders?—Shunt. The only people who insist on breech-loaders are the Japanese.

3606. (*Mr. Pole.*) Is Mr. Whitworth's system of rifling more expensive to do than yours, than the shunt?—I would rather not give any opinion upon that point.

3607. I will put the question in this form: To what extent does the system of rifling affect the cost of the gun?—Any system of rifling, I imagine, with the tools that are now made, will make very little difference in cost. Ours would be a little cheaper, perhaps, than Mr. Whitworth's.

3608. (*Col. Simmons.*) But as between the two systems of the shunt gun and the many-grooved breech-loader, is there much difference in the cost of rifling?—The cost of rifling is trifling compared with the cost of the gun; when the machinery is once made, a proper machine will rifle anything.

3609. Then, excepting the difference of the cost of the material of which the gun is built, do you consider the cost of making the whole of them may be taken as much about the same?—About the same.

3610. Whether Mr. Whitworth's or yours?—Mr. Whitworth screws a great many of his pieces together, and I should imagine that is pretty expensive. I should not like to commit myself to anything about Mr. Whitworth's; but, if anything, the workmanship of his guns cannot be made cheaper than Sir William Armstrong's.

3611. Than Sir William Armstrong's breech-loader, or muzzle-loader, or both?—Both, I should say.

3612. (*Mr. Pole.*) You can hardly compare the cost of the muzzle and the breech-loader?—We do not make any difference in our price.

3613. That is, taking into consideration the lightness of the breech gun, it would be more expensive per cwt.?—There is not very much in that.

3614. (*Col. Simmons.*) If you do not take into consideration the lightness of the gun, do you take into consideration the effect? Because the lighter 70-pounder is fired with a less charge of powder, and therefore it would be hardly fair to compare a gun with a less practical effect with another, with a greater?—The breech-loader was intended as a shell gun. In fact, it has been, perhaps, rather a mistake that with the 12-pounder we supplied shot. We never had supplied shot with a 12-pounder.

3615. (*Major-Gen. Taylor.*) You supplied shot because they were demanded by the Committee?—We supplied shot because they were demanded by the Committee; because in no case would an officer commanding in the field fire shot in preference to shell. Therefore the guns are made for shell, and all our experiments were made with a view of their being fired with shell only. I think no officer of artillery would dream of carrying shot into the field, because for all field purposes shell has all the advantages of shot, with the additional advantage of being used as shell, as they would almost always require to be used.

3616. If two guns were required, say 70-pounders, to produce the same effect and carry the same projectiles with the same velocity, would there be any difference in the expense of the two, the muzzle-loading and the breech-loading?—Yes, there would

be; the breech-loading apparatus is more expensive than the other, but, to produce the same effect, it depends upon what you define as effect. For instance, if you define as effect the penetration of an iron plate, in that case you would require the same charge of powder, and the gun would have to be as heavy, or perhaps heavier; but if you define as effect the effect which it would have upon a wooden ship, in firing shell it is clear that the breech-loader, with a lighter weight, would have a much greater effect, because in a given time you could fire many more shots. It depends upon the effect you wish to produce, whether a destructive effect against wooden ships, or batteries, or troops, or a penetrating effect as against iron ships.

3617. (*Col. Simmons.*) It appears to me as between the two guns it would be well to eliminate the question of the rapidity of the firing. If you have two guns, say, 70-pounders or 110-pounders or any other calibre, and you want to fire so as to produce a destructive effect, whether against wood or iron, the same shot with the same velocity—which would be the most expensive gun, the breech or the muzzle-loader?—The breech must be more expensive than the muzzle, because you have extra parts and extra fittings.

3618. (*Mr. Pole.*) About how much?—It is difficult to say. If we have a large number, it is astonishing how cheap we can make them; but if they are merely specimens, it would be considerable. At this time we quote the same price for breech-loading and muzzle-loading, and the breech-loading is about 15 cwt. lighter.

3619. To what sized gun does that apply?—To a 70-pounder.

3620. (*Col. Ormsby.*) Are you making any of these guns now?—Yes.

3621. Large guns?—No; we do not carry the breech-loading principle above 70-pounders.

3622. (*Major-Gen. Taylor.*) Now there is a question I want to ask you particularly. In these guns you are supplying to foreign powers, what is the proportion? Have you any fixed proportion for the weight of the shot to the gun? Is there any limit you assign to this?—It depends upon the size of the gun, but there unquestionably is a limit.

3623. Say in pounds of the shot to pounds of the gun?—The question is rather an involved one, because it enters into the amount of compression you can give to the gun-carriage in recoiling.

3624. I will put the carriage out of the question. I will put the question in a different shape. Are you making any guns in which the proportion is as low as 90 to 1?—I do not think we are making that.

3625. But you would now, from your experience, repudiate that proportion as being too light a gun?—Yes; for the charges we use at present. I believe in the 9-pounders and 6-pounders we are making the weight as low as 90 to 1.

3626. (*Col. Simmons.*) Having thus attempted to go into the cost of the guns and some of the details after some manner, now I will go to the question of the cost of projectiles. May the Committee take the cost of the projectiles, as delivered to them from Elswick for these experiments, as a fair indication of the cost which these projectiles would bear if supplied to the Government?—No, I do not think so; not at all. If the Government were to buy them in quantities, they would be 25 to 30 per cent. below what they were supplied to the Committee. You cannot manufacture in small quantities economically.

3627. We have gone up to some considerable quantities, two or three thousand rounds a week. Then, how are we to put the Committee in a position to consider the question of the comparative cost of the projectiles of the shunt gun, of the breech-loader Armstrong gun, or of the Whitworth gun?—I have already expressed my opinion that the only satisfactory way is to obtain from both parties *bonâ fide* contracts or tenders that they have out, and com-

Captain Noble.

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*Captain Nobbs.*

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pare those prices. The shunt projectiles, for example, as far as regards the machinery, it is quite clear that turning is the cheapest form of surfacing you can apply. In the first place, the surface you face is a minimum; and the next place, turning is the only nature of machinery in which you have no waste of your tool. Your tool cuts continuously; whereas in shaping or slotting, there is as much space lost when there is no cutting as when there is cutting. I think in Mr. Whitworth's gun, he has first to turn the corners of his projectiles true, and then he shapes; but these are points about which there might be endless dispute, and the only manner to settle it is that which I have suggested.

3628. Will you inform the Committee by what process Sir William Armstrong considers that the lead should be attached to the projectiles for his breech-loader?—I do not know that there is very much difference; but we are inclined to recommend the under-cutting in preference to the zinking.

3629. Undercutting involves the turning of the projectiles; they are not cast, they are tooled?—They are tooled.

3630. Have you any expression to represent the thickness of the lead on the projectile?—No, it is with reference to the depth of the groove; it is about a 20th of an inch deep.

3631. For all the projectiles?—Yes; somewhere about that. The sections you have got will show how very trifling the coat of lead is.

3632. This process of undercutting was adopted formerly in the service, and abandoned for some reason?—It was abandoned by the Royal Laboratory. They said they could do the zinking cheaper.

3633. Was that the only reason? Was it not that some accident occurred?—No; the first projectiles supplied were not undercut; they were simply grooved.

3634. (*Major-Gen. Taylor.*) The first were; but we had a considerable number lost. I do not think they flew off; but then I think there has been a very considerable evil throughout, which we have lost sight of altogether, that the action by which that lead is removed from the shell is a double one; it is dragged off, and there are counteracting influences at work?—I have never seen the lead come off in the undercut projectiles.

3635. (*Col. Simmons.*) But Sir William Armstrong is satisfied that he should revert to the process of undercutting.—He does not consider it a matter of great importance.

3636. Is that more economical?—More economical as far as our experience goes. It appears that the Royal Laboratory experience is different.

3637. To what extent would that economy go. Have you any per centage?—It is very difficult to give an idea. It would not make any very great difference in projectiles; perhaps one or two per cent.

3638. (*Mr. Pole.*) Was there not some difficulty about the galvanic action when the lead came in contact with the iron?—There was a little; there was a certain effect produced when the sal ammoniac got inclosed with the lead and it made great blisters upon the shell.

3639. I mean in the undercut?—Oh, no, nothing; it cannot get into it.

3640. Cannot the rust get between the lead and the iron?—No; we have had projectiles lying all about at Tynemouth exposed to the air for years, and we have had them in the water without any action having set in.

3641. (*Col. Simmons.*) Alternately wet and dry?—Alternately wet and dry, and there has been no action of that kind, not even at the point where the substances were in contact.

3642. (*Mr. Pole.*) You know of no objection to the undercutting process?—There is a trifling objection, and that is the way the projectiles are carried in the limbers. The shaking loosens the lead on the

nose of the shell, more than when it is attached by zinking. I was myself in the inspector's department for some time, and the old case shot bore travelling very badly. Segment shell bore travelling a great deal better than that, and then again the wooden bottoms that were attached to smooth-bored shell travelled very badly. On the whole I think the breech-loading ammunition bears travelling as well as the old, but the shunt is still better.

3643. (*Capt. Wilson.*) Undercutting was substituted for the tinning process?—Yes.

3644. Then afterwards the undercutting was abandoned by Government for the zinking?—Yes; the zinking does unite chemically and generally very well. The subject is quite open to question, I am quite prepared to admit that the zinking might be as good or better.

3645. On the whole yourself and Sir William Armstrong would prefer the undercutting?—Well really I cannot say. As a mere matter of manufacture I would prefer the undercutting, but I should think the experience of the service would be somewhat in favour of the zinking as General Taylor has remarked. The zinc certainly never comes off: it is a question whether the undercutting may not sometimes.

3646. It has all still to undergo the test of time?—Well I think there has been sufficient time.

3647. (*Col. Simmons.*) Has the zinking process been proved for the last five years?—As long as four years, it will be five years soon. It was introduced at the end of 1860.

3648. (*Col. Ormsby.*) The cost of the tools that are obliged to accompany the breech-loader; would they add much to the expense of the guns? What per centage?—A set of tools would do for a battery, it is not necessary to have them to each gun. I should think perhaps it might be 2 per cent. on the cost of the gun. If you take it upon the whole battery it would be almost inappreciable.

3649. (*Mr. Pole.*) What is the cost of a set of a 12-pounder facing tools?—10*l.* or 12*l.*

3650. And that would be sufficient for a battery of six guns?—Yes.

3651. (*Col. Simmons.*) Is there much difference in cost between the breech-loading ammunition and the shunt ammunition?—No, very little if we made them in very large quantities.

3652. But which would the difference be in favour of?—In favour of the shunt ammunition, not very much.

3653. What is the process of putting the studs into the projectiles?—They are simply put in, and then passed through a die by hydraulic pressure.

3654. And how is the position determined; those holes are bored?—They are drilled. We could cast them, but we do not recommend it.

3655. They are dove-tailed, are they not?—Yes, they are dove-tailed; you could cast them dove-tailed quite well.

3656. (*The President.*) The portion that goes into the metal expands under the hydraulic pressure?—Yes.

3657. (*Col. Simmons.*) You prefer the process of cutting the holes out by tools?—I should recommend it. I am merely saying as a matter of fact, that were it necessary we could dispense with both turning and drilling holes. But taking into consideration the accuracy with which any Government would require shot to be made in our days, we consider it necessary to tool the shot and drill the holes.

3658. Is that an expensive process?—No, it costs very little.

3659. Whether for large or small projectiles?—Yes; the holes are nearly the same in all.

3660. In the 12-pounder how many holes are there?—Six, I believe.

3661. Are not there nine?—Nine in a common shell, six in a segment shell.

3662. In a larger projectile there are more?—Yes, a great number.



3663. What is your rule as to the number of grooves you place in a shunt-gun?—We have six for the 150, eight for the 300, and ten for the 600 pounder.

3664. What is your rule as to the number of studs in each?—The pressure required to drive the projectile. We know the strength of the stud.

3665. What does that amount to practically in the different guns; what have you worked it out at? Do you know how many holes there are in each?—It depends upon the length. The pressure on a common shell is greater than on a shot, because the radius of gyration is longer.

3666. (*Mr. Pole.*) What is the amount of machining on one of the shunt shots compared with what you know of Mr. Whitworth's hexagonal projectiles, less or more?—I should say it is less. The amount of machining is this, that we turn and we drill the studs. That is all the machine work that is upon a shot.

3667. (*Capt. Wilson.*) Is that all the work on a shot?—Yes.

3668. In all cases?—Yes; but of the first shot we made some were turned and some were not.

3669. Do you put the shot in a lathe after the studs are in so as to turn the surface of the studs?—No, we do not; we put them into a die.

(*Mr. Pole.*) Which not only forces them into a groove but impresses upon them their bearing place.

3670. (*Capt. Wilson.*) Does it get them at all into shape?—Yes; there is first a roughing die to give them the rough form, and then finally a finishing form. Then the die necessitates that the groove shall have exactly the right twist and all that sort of thing. We actually did supply the British Government with a number of 12-pounder segment shells at 2s. 10d. each. I merely mention that as a price about which there can be no dispute.

3671. (*Col. Simmons.*) The segment shell complete?—Not including the fuse.

3672. Bouched and ready for the reception of the fuse?—Bushed and ready for the reception of the fuse.

3673. (*Capt. Wilson.*) What is the price of one of ours?—4s. for a 12-pounder segment shell.

3674. (*Col. Simmons.*) And a common shell 3s. 6d.?—Yes.

3675. (*Capt. Wilson.*) That, of course, is because it would not pay to make so small a number cheaper?—Yes.

3676. (*Col. Simmons.*) Then as regards fuses?—I can only state the prices that we have made them at for the British Government, and if ordered in sufficient numbers we should make them again; we would make them again at the same price. I think the lowest charge at which we supplied the time fuses was 2s. 6d. each; but we offered to supply them at 2s., because the 2s. 6d. included the expense of experiments. Then, with regard to the concussion fuse, we supplied them at 1s. each, and the pillar fuse I think at 1s. 10d.

3677. (*Col. Simmons.*) Do those prices apply to all sizes?—All sizes together; with the time fuse it does not. With regard to the time fuse, owing to the especial requirements of the British Government, there has to be an adapter used with it.

3678. Then the adapter would be an extra to the time fuse?—Yes; the fuse itself would be the same.

3679. What is the price of the adapter?—6d., I think, but that is not a peculiarity of the Armstrong gun.

3680. (*Capt. Wilson.*) You have also the time concussion fuse?—Yes; some officers might say in firing at some important object, in order to make sure it is worth while to throw away an extra 1s.; in case my time fuse should not act my concussion fuse will.

3681. We have them and we have tried them; what is the price?—It is just the two combined. They are merely fastened in together.

3682. (*The President.*) Does anything more suggest itself to any member of the Committee to ask Captain Noble with regard to the cost?

(*Mr. Pole.*) I suppose you cannot give a general notion of the price per cwt. for finished guns of certain sizes?—Yes, I could give that. I remember with regard to projectiles, as we are upon that subject, I showed the Committee upon Ordnance that we were actually supplying the Armstrong projectiles with all their refinements at a lower price per ton than the Government had bought the smooth bore diaphragm shrapnel shell.

3683. (*Captain Wilson.*) Made them?—No; they were bought, because at that time we were disputing the accuracy of the Government in not having allowed for plant and depreciation, and a number of things which the manufacturer is compelled to include.

3684. (*Mr. Pole.*) How do you think the price per cwt. would apply; would it be different for different sizes of guns?—Yes.

3685. Very different?—It would be large of course for small guns; up to a certain extent the smaller guns would be the largest, and then the price per ton goes on diminishing up to a certain size, and then it increases again.

3686. Do you think it would be at all a useful kind of data if you were to give us the price per cwt. of different sizes?—That is simply giving you the price of the guns; but I will do it gladly if the Committee wish.

3687. Would it enable us to say that, supposing we wanted to make a 12-pounder gun a cwt. heavier, it would increase *pro rata* at the same price per cwt.?—No, I think not. The cost of the workmanship of a 8½ cwt. gun and 9 cwt. gun is just the same. The reason that an experimental gun costs so high is that you have almost invariably to make special tools. When we made our first 600-pounder the cost of the mere tools were over 800l., the cost of the mere tools for making the gun.

3688. (*Major-Gen. Taylor.*) In fact there would be degrees at which you could use the same tools, but when you get to that point at which you must have a fresh plant to carry out the manufacture, then the price would be increased?—When you get to large sizes you require larger furnaces, larger hammers, heavier lathes, heavier boring machines, and heavier rifling machines, and so on.

3689. (*Col. Simmons.*) And that cost is generally distributed over a smaller number?—Most probably. I think our price for the first 110-pounder common shells we made for the Government was 23s. 6d. each; before we ceased to manufacture it we were only receiving 13s. Unless we perfectly understand each other we may state a price for large quantities, and others may state for small quantities, and others may state the mere labour and material. It is perfectly easy to imagine a projectile in which the cost of labour would be next to nothing. In fact the embarrassments are endless in arriving at the cost of these things. I am sure Sir William Armstrong would have no objection to my laying before the Committee the prices we are now getting on contract if it be fairly understood that Mr. Whitworth will do the same.

3690. (*Col. Simmons.*) Both for guns and ammunition?—Both for guns and ammunition. But it must be no special tender. I have given the Committee already an example. We sent in our tender and Mr. Whitworth sent in his. Our price was somewhere between 1,600l. and 1,700l., and Mr. Whitworth's, I am informed, was 3,000l.

3691. Both guns were 12 tons?—Both. It must be so with regard to the guns. The only question can be with regard to the projectile, because the material with which Mr. Whitworth works is so much more expensive than the material with which we work, that it is impossible that he can make his large guns as cheap as we can. When we got our last 600-pounder

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*Captain Noble.* barrel we paid 130*l.* per ton, the previous price, 120*l.* having been found insufficient by the makers.

3692. In the manufactured form?—Yes.

3693. In what form did you get the barrel of your 600 pounder?—We get it as a tube. It is the only size which we get as a tube.

3694. (*Major-Gen. Taylor.*) By what process is that made, not by the new process of drawing tubes?—Oh, no; it is cast hollow and then drawn on a mandril.

3695. (*Col. Simmons.*) In that 300-pounder gun that you speak of you give the relative cost of the guns supplied by you and Mr. Whitworth, at what price would you have put the ingots of steel to make that gun?—At 300*l.*

3696. 300*l.* a ton?—No; 300*l.* the ingot.

3697. (*Mr. Pole.*) What weight would the ingot be?—Well, I suppose about three tons.

3698. Then about 100*l.* a ton?—About 100*l.* a ton.

3699. (*Major-Gen. Taylor.*) That would give a proportion, supposing you take the relative value of the guns, with the cost which the guns bear to the relative value of the material, supposing your ingot cost you 100*l.* a ton, it would make the wrought iron cost 54*l.* or 55*l.*?—The material which we employ to make a gun of twelve tons, would be about 24 tons weight. We cut nearly half away in waste.

3700. To make a 12 ton gun?—Yes.

3701. (*Mr. Pole.*) Including the wrought iron?—Yes.

3702. That reminds me I never got a direct answer to a question I put very early in the day; I was asking it when the inquiry went off to something else. You said that taking the cost of iron for the coil at 20*l.* a ton, when you have forged the coil and prepared it for the lathe you conceived it was worth 10*l.* more, that is 30*l.* a ton?—Yes.

3703. Do you estimate that on the rough coil or the turned coil?—On the rough coil.

3704. How much do you turn off it, you will not lose as much as in the barrel?—No; I can only state roughly what I have already stated, that taking a finished gun at 12 tons, the material we lose is about 12 tons. There would be a good deal lost in its coiled state; first there is the heating for coiling, and then the loss in welding up.

3705. (*Col. Simmons.*) Then the two costs of 3,000*l.* and 1,600*l.* of a 12-tons gun—You had better put it at 1,650*l.*, it is a little below that, but I am not sure how much.

3706. That would give you 250*l.* a ton for the steel

gun and 137*l.* for the iron with the steel tube?—Yes; the barrel itself being worth something like 300*l.* before machining.

3707. When solid?—When solid. A 600-pounder barrel is worth 600*l.* before anything is done to it; the 150-pounder barrel is worth about 180*l.* before anything is done to it. I merely give you these figures to show you the expense of the steel.

3708. (*The President.*) Has there been any reduction in the price of the steel?—Some sizes they have reduced slightly, others they have put up; the 600-pounder, for instance, for which they considered 120*l.* quite sufficient they charge 130*l.* per ton for.

3709. (*Mr. Pole.*) Do the three makers you have named agree pretty nearly in the price of the barrels?—Pretty nearly; Krupp is the most expensive.

3710. They are sufficiently uniform to enable you to form an idea as to the probable price?—They do not seem disposed to come down.

3711. What is the price of Jessop's bar tool steel?—I should think about 70*l.* a ton; I mean, of course for small tools.

3712. (*Major-Gen. Taylor.*) You say you have been making of late breech-loaders to a certain extent?—Yes.

3713. Has there been improvement made in the construction of metal vent-pieces?—Yes, in the 110-pounder there is a difficulty with the vent-piece, even when they pay great attention to it. The 110-pounder is not so successful as the other breech-loading guns. The 40-pounder there is no great difficulty with, and it is a very successful gun. The 9 and 12-pounder are perfectly manageable.

3714. (*Col. Ormsby.*) These vent-pieces will give on the small guns?—Occasionally, but very few; and you have got some of the defective patterns in the service yet, some of the earlier patterns.

3715. (*Mr. Pole.*) Have you established yet any system of machinery or invented any instrument for the rebushing of the side-closing breech-loader?—Yes, we have rebouched them.

3716. (*Col. Simmons.*) You must have a special instrument for that?—There are special tools.

3717. You have machinery in your factory; but can that be sent to out-stations?—One of our men rebouched one of your guns at Shoeburyness.

3718. (*Capt. Wilson.*) In fact, he bushed it; it had not been bouched before at all?—Yes.

3719. (*Col. Simmons.*) Bushed it with steel?—Yes.

Adjourned sine die.

Tuesday, 7th February 1865.

PRESENT:

MAJOR-GENERAL RUMLEY.  
MAJOR-GENERAL TAYLOR.  
COLONEL ORMSBY.  
COLONEL SIMMONS.  
CAPTAIN WILSON, R.N.

CAPTAIN SINGER, R.N.  
MAJOR YOUNG.  
MR. POLE, C.E.  
MR. McDONALD.

MAJOR DYER, R.A., Secretary.

MAJOR-GENERAL RUMLEY IN THE CHAIR.

Mr. WHITWORTH examined.

*J. Whitworth,*  
*Esq.*

7 Feb. 1865.

3720. (*Major-Gen. Taylor.*) In the instructions we have, here to-day, I find that in the inquiries is included, amongst other things, "Also to take into consideration the comparative cost, so far as it can be ascertained, before the manufacture has been practically ascertained?" Are you prepared with a statement to lay before the Committee on this subject?—No, I have prepared no statement; but I am prepared to answer any questions that may be put.

3721. Have you any proposal to make yourself as to the manner in which you could most readily lay before the Committee a synoptical view of the cost of the manufacture of your gun?—It is a very difficult matter to state what the cost of a thing is.

3722. It will be as well to assimilate your examination as closely as possible to what we did in the case of Sir William Armstrong. Is there any difference between the construction of the 12-pounder gun



which you have furnished for the experiments and the construction of those with which you have hitherto carried out your experiments?—No; there is no difference.

3723. Will you be good enough to give us, in as few words as you can, the mode of construction of that gun: what you consider to be its chief characteristics?—The 12-pounder gun?

3724. Yes?—The 12-pounder, as you know, is made of the homogeneous metal tempered. With reference to the size of the bore and the rifling, you do not wish me to go into that.

3725. That is already recorded; there is no difference, you say?—No.

3726. You might state what the nature of the barrel is, and whether it is in solid material?—Yes; the 12-pounder is a solid gun. To give a proper description of the guns, it would be desirable to have the drawings, and to point it out upon them (*the drawings were produced*).

(*Major-Gen. Taylor.*) The whole of the construction of these guns is upon record.

(*Col. Simmons.*) Yes, perhaps it would facilitate matters, if Mr. Whitworth would give us, with respect to the 12-pounder, a description of the manufacture as carried on. For instance, the Committee have not before them whether the steel tube or barrel of the gun is forged, or cast solid or hollow, or the manner in which it is manufactured; Mr. Whitworth might give us a statement of those points, and a description of the manufacture.

3727. (*Major-Gen. Taylor.*) The whole of it is on record in the former examination, I think. You were examined very fully on those points at your first examination, were you not?—Yes, I think so.

3728. Is the material of which the barrel is made supplied by the trade, or is it prepared in any particular manner at your own factory?—No; the material of which these guns are made was supplied partly by Krupp and partly by Firth.

3729. Are you content to trust to them for the supply, or do you subject it to any certain tests yourself to ascertain its uniformity and safety?—Oh! yes; we test each piece.

3730. The question being one of cost which we are considering just now, the Committee wish to know whether, in purchasing this metal, you pay any patent right for it?—No.

3731. Do you use the metal as you procure it, or do you subject it to any further manipulation or treatment, with a view to satisfy yourself as to its meeting all your requirements?—We subject it to the hardening and to the tempering process.

3732. (*Mr. McDonald.*) You were asked by the General whether you paid any patent right for your steel. When you purchase from Firth, may I ask, do you purchase under an agreement?—Yes.

3733. What is the nature of that agreement?—We took out a patent partly for the construction of the gun, partly for the material of which it was made; and we have an agreement with Messrs. Firth, that for all gun material which they supply they pay us 2 per cent.

3734. That they supply to whom?—To other parties.

3735. (*Col. Ormsby.*) All the steel?—Yes; that they make for other parties for guns. There is one exception, I think, in the case of the rifle barrels that they supply to the American States; but for all the material that they supply in this country they engage to pay us 2 per cent.

3736. (*Mr. McDonald.*) Then, under that agreement, you expect Messrs. Firth to pay you this royalty, or whatever you choose to call it, upon any steel which they may have sold to other parties for gun manufacture?—Yes.

3737. (*Mr. Pole.*) Are you aware that Messrs. Firth have positively denied, in writing, that they pay any royalty on the material that they supply to Sir William Armstrong?—I have heard say that they

have denied it, but I shall be very happy to put in the original agreement for you to see.

3738. (*Col. Ormsby.*) Have you received any money?—No; they have not yet paid us any money.

3739. (*Mr. Pole.*) Would you state for what particular point or invention the royalty would be payable on material supplied to Elswick; for what particular invention, with regard to the particular manufacture of the steel would the royalty be payable? Of course it is public property, being a patent; there is no secret about it?—Oh! there is no secret at all. The patent was to enable them, principally, to make the material much larger by having a hole for the hoops in the centre, either by casting it, or boring it out and hammering it upon mandrills. That was the chief feature to enable them to make larger material with the hammers they then had in existence. We wanted larger material than they were able to manipulate, and this was a mode of enabling them to manipulate larger material.

3740. Then it would not be payable for any barrels or ingots of steel that were supplied solid?—Yes, it included all; because in the first instance when they commenced, they sent us the material and we tested it. They had no means of knowing whether it was suitable for guns. We used to test this material, and tell them exactly what it would stand, and so enabled them to make the material that we wanted.

3741. But what can there have been in a solid barrel different from what had been supplied before the date of your patent?—Nothing; as far as the solid material went, there was no difference.

3742. Then the royalty would not have been payable on a solid barrel?—But they engaged to pay it.

3743. Even though it was not claimable under the patent?—Yes; they engaged to pay it because of the benefit they derived from the tests that we made of the material; they engaged to pay it along with the other; there was no exception.

3744. What! they engaged to pay royalty on a thing which was not included in the patent?—Yes.

3745. It is a very unusual agreement; I never heard of such a thing in my life before?—I believe there is no exception made in the agreement; I think not.

3746. (*Col. Simmons.*) Instead of being a royalty it appears it was a payment under the private agreement between yourself and these manufacturers?—Yes; it was not considered as a royalty; it was considered, in consequence of the assistance we rendered them, we should have 2 per cent., I think it was, on whatever they sold to other parties.

3747. (*Mr. Pole.*) It is not a royalty but a percentage?—Yes.

3748. (*Col. Simmons.*) It appears, Mr. Whitworth, from the account given of your guns previously manufactured, that the field guns were manufactured solid?—Yes.

3749. But in the guns that have been delivered to us, it appears that there are certain additions to the gun; an addition of a jacket, if it may be so called, or hoop over the breech, and also the trunnion pieces are different?—Yes.

3750. Probably you could state to the Committee the apparent difference there is between the description of the solid gun and the gun as delivered?—Yes; I will explain how that was. I contemplated, as you are I think aware, to fire the gun by means of the vent at the end.

3751. (*Major-Gen. Taylor.*) In the axis?—Yes, through the end of the bore; and some of my friends thought that it would be very desirable to have the old mode of vent as well. You will see that, by the old mode of vent the gun is wounded, if I may so say; it is injured to some extent; it is weakened; so when I put in this ordinary vent, I then thought it was desirable to put on this extra hoop.

3752. As an additional protection rendered necessary by the alteration of the vent?—By putting in this vent, which I did not originally intend to do.

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3753. (*Col. Simmons.*) If you were to make your guns vented only, according to your original intention, in the line of the axis of the piece through the breech, would you or not consider it necessary to place that hoop over the breech?—Certainly not; I should not put it there.

3754. Then your trunnions; was it always intended that they should be put on in the way that they have been, apparently by a screw?—Yes; by a screw.

3755. In addition to that, is the piece which carries the trunnion merely screwed on or put on over the gun when hot, or merely attached by the screw?—Put on cold, depending entirely on the screw.

3756. (*Major-Gen. Taylor.*) There is no screw in this at all?—Yes.

3757. (*Col. Simmons.*) How is that ring put on the breech-piece?—It is pressed up by hydraulic pressure.

3758. Not by heat?—No.

3759. Do you consider the application of heat in that way might have an effect on the temper of the steel if hoops of steel are shrunk on over masses of steel, would it have any effect on the temper of either mass of steel?—No, it would not.

3760. You stated that you received the gun in a solid form I think from the makers of the steel?—We have received them both ways. We have received the barrel with a hole through it as well as receiving them solid. We have had them both ways.

3761. But were they cast solid in both cases in the first instance?—No.

3762. Then sometimes they are cast hollow and sometimes solid?—Sometimes they are cast with a core.

3763. Are they hammered after casting?—Yes, hammered on mandrils.

3764. And do they undergo any hammering process by yourself after receiving them?—No.

3765. Has that all been undergone at the factory of the steel?—Yes; we do not hammer them.

3766. You merely temper and harden?—Yes.

3767. Have you any objection to describe the process by which you temper and harden them, so that the Committee may form some idea of the cost of the process?—The metal is simply heated to a certain heat and immersed in oil.

3768. Is that heat ascertained by thermometric measurement, or does it depend on the skill and judgment of the individual who works it, the individual in charge of the furnace?—Before heating the gun, we take off a small portion of it and heat it and try its strength, and if we find it insufficient in strength we then take another piece and make it a little hotter; then we compare the two, so that we find out by experiment what is the best heat for that particular gun, the particular piece.

3769. Is that heat determined or measured by thermometric measurement?—No; merely from its appearance.

3770. Can you apply that test to a large mass of steel, as there would be in the gun itself, with such certainty that you can feel perfect confidence that the result obtained in the large mass would be the same as you had obtained in the small mass?—Yes.

3771. What test do you apply afterwards to the large mass in order to make sure that you will have the same effect, or do you apply any test?—No; we do not apply any test.

3772. You merely trust to the test you have previously obtained as to the small portion?—Yes.

3773. (*Major-Gen. Taylor.*) You say that you test two pieces in order to ascertain the exact amount of temper that is most suitable to that piece of metal, to the metal of which you are going to make this particular gun?—If it has stood what we deem a good test, sufficient, then we do not try another; but if we find it very inferior, then we take another piece. Sooner than sacrifice the thing and throw it away we take off another piece and subject it to different heat;

and then in some cases we have taken off a third before we would throw the thing away.

3774. (*Col. Simmons.*) From which end of the gun do you take the pieces?—From the breech end.

3775. Are the ingots cast upwards?—Yes, vertically.

3776. Do you find much difference between the two ends of the ingots?—Not generally; sometimes. That will depend upon the length that it has been cast. Sometimes they do not leave it sufficiently long for the sort of metal. In that case the muzzle would not be so good as it ought to be.

3777. (*Major-Gen. Taylor.*) Do not you make it a condition with them that they shall cast them with a certain dead head as a margin, in order to insure closeness of metal towards the muzzle?—Yes, they do that generally. Generally speaking the muzzle is sound.

3778. (*Col. Simmons.*) Is the ingot as delivered to you much longer than the gun itself?—No, they cut it off.

3779. What may be the price of the metal so delivered to you?—It varies now from about 60*l.* to 90*l.* per ton, according to the size.

3780. Increasing as it gets larger?—Yes.

3781. But none less than 60*l.*?—None less than 60*l.* for guns.

3782. (*Major-Gen. Taylor.*) What is about the price per ton of the 12-pounder?—60*l.*

3783. (*Col. Simmons.*) That is the ingot as delivered to you solid?—Yes.

3784. (*Major-Gen. Taylor.*) That is in its state before working up into the gun. What do you consider, in rough terms, is the comparative value of the metal after it is worked up per ton? Would not that depend on the size of the gun in a great measure?—Yes; it differs in the different sizes of guns.

3785. (*Col. Simmons.*) Having received the ingot and tempered it, what is the next process to which you apply it in making the gun; do you put it into a lathe? Is that the next process?—No; I must explain. The first thing we do after we receive the material, the barrel, is to put it in the lathe and turn it from one end to the other.

3786. Turn and bore?—Then, after turning it from one end to the other, we put it into the lathe, and, as we term it, rough bore it to get the hole through this when the material has been roughed out and the hole bored, we harden and temper it. We do not harden and temper when we receive it, but we first turn and bore it, then harden and temper it.

3787. Then you go through the process involving all this labour before you apply the test as to whether the steel is likely to answer your purpose or not?—No, we do not. The first thing we do is to turn off a piece from the end in order to try our tests, and we get the tests made. Very often it happens that the tests are going on at the time the thing is being roughed out.

3788. Can you give the Committee any idea of the proportion of the ingots you have to reject; is it small or large?—Small.

3789. Can you give me any idea of the per-centage or proportion?—No, I could not.

3790. Of course the certainty of manufacture affects very materially the question of cost. If there were a large number of rejections it would affect very materially the cost of the gun?—Yes; I should be very happy to get it out and submit it to the Committee.

3791. (*Major-Gen. Taylor.*) Supposing an ingot is rejected from being found defective, that is a loss to the supplier?—We should return it and get another. The loss of the workmanship would fall upon us.

3792. The loss of the workmanship would fall upon you but not the loss of the material; the makers would have to take that back and replace it?—Yes; precisely.

3793. There is no arrangement by which a diminished charge is made for imperfect material; I mean, you are not bound to pay at all for any material that



fails, but they have to replace it?—Yes, they have to replace it.

3794. (*Col. Simmons.*) Then having roughly bored it in that way, what is the next process of the manufacture?—After it has been tempered?

3795. Yes, after it has been tempered?—We turn it again outside; then we get the finished boring and the rifling.

3796. Then in the first rough boring is it only bored cylindrical?—It is only bored cylindrical.

3797. (*Major-Gen. Taylor.*) As you have to continue the work upon the metal after this tempering, do you find any great additional difficulty in working, showing that a considerable change has taken place by the process of tempering? Do you find it more difficult to work?—Sometimes. Formerly we found greater difficulty than we do now; and sometimes we had to reheat and lower the temper from being too high. We had to temper it a second time.

3798. (*Col. Simmons.*) For the sake of the cutting tools?—Yes, for the sake of the cutting tools.

3799. Can you give the Committee any idea of the per-centage of additional value which the gun has acquired by this process as compared with the ingot as received by you?—Well, that varies very much.

(*Major-Gen. Taylor.*) It would vary with the size of the gun you said just now.

3800. (*Col. Simmons.*) I mean in the 12-pounder?—In the same size of the gun it has varied very much. Sometimes the material would be improved as much as 50 per cent. by this process of hardening and tempering. In some cases it would not be improved at all.

3801. You mean improved as to its strength?—As to its strength.

3802. The question which I asked had reference to the additional cost, the additional money value put upon it by the labour. For instance, we had a statement the other day, in considering this point with regard to the Armstrong guns, supposing an ingot has cost a certain sum of money, by the time it has got into the form of a gun barrel it has acquired an increased value of so much per cent. upon the original cost of the ingot?—Yes.

3803. Would you give the Committee any idea of what additional value you consider has been put upon the gun by the various operations which it has gone through in your factory before it has become a gun barrel?—That would be the difference.

3804. I am limiting the question to the 12-pounder which we have before us?—Yes. If we give 60*l.* a ton for the material and we sell the gun for 120*l.*, then, of course, that would be four times.

3805. (*Major Young.*) Twice, would it not be; cent. per cent.?—The gun weighs half a ton, 10 hundredweight.

3806. (*Major-Gen. Taylor.*) Then it would be four times?—Yes; then that is the finished weight. The gross weight would be more.

3807. But that includes your profit also?—Yes.

3808. But what Colonel Simmons means, I think, is this; he wants to know what is the actual increase of cost with regard to the possible adoption of the manufacture by Government. What would be the increase of the actual price of that metal after working the metal into your barrels?—There is nothing more difficult than to arrive at what the cost is.

3809. I know it can only be approximately?—It is extremely difficult. And as you want to ascertain, I presume, the comparative cost of this gun and projectiles with the other guns and projectiles, I should submit that you should ascertain the actual time spent upon all the different processes. Never mind the money value at all; take the actual time spent in each process and compare those.

3810. (*Col. Simmons.*) How shall we ascertain it? Do you wish the Committee to go down to the various factories and watch the process from beginning to end; it is exceedingly difficult for the Committee to ascertain that point?—It would not be

convenient, perhaps, for the Committee to do that themselves so far as relates to the guns, but that is not so important, I think, as it is with reference to the projectiles. You might ascertain the cost of the projectiles, which is of far more importance than the cost of the gun. You might ascertain by personal inspection; it would take a very short time to witness the time spent upon each process in producing the projectile.

3811. (*Mr. McDonald.*) Will you explain why the cost of the projectile is, in your opinion, of far more importance than the cost of the gun?—The gun is a steel gun, and its life will be a very long one. Of course, the projectiles are continually being shot away. They are a constant expense.

3812. (*Col. Simmons.*) But still the cost of the guns, where the guns have to be supplied in very large numbers, is of very material consequence. Of course the Government would have to supply these guns, and our instructions are to endeavour to arrive at some idea of the comparative cost of the gun as well as of the ammunition. Might we take the cost at which these experimental guns have been supplied as a fair criterion of the cost of your guns of large calibre in all future times?—Certainly not.

3813. Tell us why?—The manufacture of this material for guns is a new manufacture, and it is very much dearer now than what it is likely to be. What we are now paying 60*l.* per ton for I have not a doubt we shall, before very long, get for half the money; we shall get it for 30*l.* Therefore it would not be right to assume that this great price is going to continue.

3814. Has this material already cheapened much in the production?—There is what is known as the Bessemer process. We have had some of that material and some of it has turned out very good, and that now can be had at a very much less cost. I suppose that material now can be had from 30*l.* to 40*l.* per ton. They are now beginning to use it very extensively on the railways. I was at Crewe about a fortnight ago (if you take this down it will be interesting to you to know it), and I found they were putting down a very large plant for the manufacture of all the railway axles, the crank axles, of this material.

3815. The Bessemer?—Yes; the tires of all their wheels are going to be made of this material. Formerly, as you may remember probably, on the Great Western Railway, they had great difficulty with iron in getting it to stand, and Mr. Gooch took out a patent for steeling the tires of wheels; but now they are making great preparations for having all the tires of this improved material, and also all the rails. The rails, not long since, were made with steel and iron, a piece of steel put on the top of iron, but that is now abandoned. Instead of having a combination of iron and steel, they are now going to have the whole rail of steel, and Mr. Ramsbottom informed me that at Camden Town there is the steel rail and the iron rail side by side, and the steel rail is now perfectly good, and there have been seven iron rails worn out alongside it.

3816. (*Major-Gen. Taylor.*) Has it been there long enough to be subjected to the action of frost to any extent?—It must have been to have survived seven iron rails. Only 10 days ago Mr. Ramsbottom told me that the steel rail is perfectly good still.

3817. (*Mr. McDonald.*) And how about marine engines?—I do not know to what extent Bessemer steel has been applied for marine engines, but I know that the Peninsular and Oriental Company are having paddle wheel shafts and screw shafts of steel. Krupp has supplied a great deal, and the Messrs. Firth, of Sheffield, are now supplying it.

3818. (*Col. Simmons.*) In fact, from what you state now, it would appear that you are under the impression that steel will, in a great measure, take the place of wrought iron in certain engineering works?—Yes, in all important operations, I believe.

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3819. Where great strength is required or lightness, or what quality becomes essential?—Of course, if you get much greater strength, you can have the thing lighter; there is great economy there.

3820. Do your proofs tend to convince you that you can make steel with the certainty that has been acquired now in the manufacture of wrought iron, that you can have that thorough dependence on it?—Although I rendered Messrs. Firth so much assistance, they were very chary about letting us know anything about the process, and when we found this great inequality that existed, of course it was very unsatisfactory to us, therefore I determined to put up a small steel works myself, for the purpose of experiment, and I am happy to say that I believe we shall get steel with much greater certainty than iron.

3821. (*Mr. Pole.*) You have not at present sufficient confidence in this cheap Bessemer steel to use it for the purpose of guns. I think I gathered that from what you said?—I have no hesitation in saying that I should very much prefer using the Bessemer material to iron. But the Bessemer material at present is not equal to the material melted in the crucible in the ordinary way.

3822. And you have never, in point of fact, used for guns of any importance any but that very best crucible material?—I think we only made one gun of the Bessemer material.

3823. (*Col. Simmons.*) Have you any objection to describe to the Committee the proofs to which you submit this steel before admitting it into your guns?—I shall be very happy to give you the results.

3824. If you won't describe the process, the next best thing is to get the results, perhaps you will give us the results?—Do you mean with regard to the difference of strengths that we have obtained?

3825. As to the actual strengths that you have obtained from the steel. Do you submit it to tensile strain?—I will say this, that I shall be very happy, if the Committee desire it, to show everything to the President, and to any other member of the Committee in confidence. I will show everything.

3826. (*Mr. Pole.*) I do not see what good it would be?—The great object is to get an idea of the certainty.

3827. (*Col. Simmons.*) Do you find great variations in the results of your experiments in the material?—Formerly very great.

3828. But at present?—Not so great now.

3829. But still you find considerable difference?—Yes.

3830. (*Major-Gen. Taylor.*) I will put the question in this way, Mr. Whitworth: Is your confidence in the manufacture of that steel such as to satisfy you that the homogeneity of that metal throughout may be fairly estimated by that small piece that you take off, to test beforehand; because you have no means, as I understand you, of again testing the metal after it has been subjected to the tempering process?—Except by proving the gun. If we find that the material shows no flaws, but perfect soundness, then we have every confidence.

3831. But that is the portion that you test. I am only asking for information whether it is not possible that in an ingot of a considerable size, which you test in this manner, there may be perfect excellence in this material at the part which you have selected for testing, while there are defects which never came to your knowledge in the other portions?—But they would come to our knowledge; the defects would appear either in the boring or in the outside turning.

3832. There might not be flaws, but, as you have already said, there is a difference in the closeness of the texture of the metal towards the muzzle to what you find at the breech, the casting being a vertical one, may there not be defects of manufacture in the metal which never come under your observation, and which would be sources of danger and uncertainty?—Practically we do not find that there are; but no

doubt there will be differences in the metal. If we find there are no flaws, no shady places in the material, we have every confidence in it if the test has been right.

3833. (*Mr. McDonald.*) How do you express the result to which you have arrived with reference to this particular form of steel as against wrought iron?—It is from two to three times as strong. If you prepare a piece of material of the best wrought iron of which guns are made, and make it into anything you please, I will prepare a piece of this metal, subject it to the process that I employ, and it will stand, probably, three times as much as the iron.

3834. That is to say, your steel hoop you have engaged to be twice or three times as strong as any wrought-iron hoop?—Yes.

3835. (*Col. Simmons.*) You said just now, Mr. Whitworth, that the process of procuring steel would probably be very much less costly at some future time than it is now?—Yes.

3836. From your knowledge of the cost of the material, as well as the processes to which it is subjected, and therefore the cost of the labour laid out upon it in the production of the ingot, do you imagine that the process will ever be so cheapened as to reduce it to the cost of good wrought iron?—No; it will always be more expensive to work than wrought iron; but it will be far cheaper; that is to say, if you make a gun to do what I conceive a gun ought to do. If you are satisfied to put in a short shot with half a charge of powder, then wrought iron may do; but if you want to fire a shot of a proper length, of the best length, with the best charge of powder, that is to say, as much powder as the gun can consume, I have no hesitation at all in saying that wrought iron will not for any length of time stand that. It will undergo a permanent alteration, and no metal can stand when it once begins to go. Take the service 110-pounder, for instance, the 7-inch bore; the best charge for a 7-inch bore gun is, according to the quality of the powder, about 20 pounds, not less. But if you are satisfied to fire that gun with 10 pounds and with a shot of, say, two diameters long, you put no strain upon the gun, and therefore you may make it of almost anything; but if you want to fire a proper charge with a shot three diameters long, 150 pounds weight. If you fire that with a 10 pounds charge instead of a 20 pounds, then you may say that steel is not necessary, but I would not have anything to do with guns to fire those small charges.

3837. What would be the weight of that 7-inch bore gun to take that charge?—The best weight would be about seven tons, on account of the recoil.

3838. (*Mr. McDonald.*) Take the 70-pounders that we have had under trial. What is the proper charge for that sized gun?—With the powder we have had at Shoeburyness it would appear we get as much from 10 lbs. in my gun as we get from 12. We have had 9,500 yards range, at 33°, with 10 lbs. of powder, and we only got 100 yards more with 12 lbs. of powder.

3839. What was the powder?—It was a slow consuming powder.

3840. A reduced quality of powder?—A slow consuming powder, which was made for the lead-coated shot, so I was informed.

3841. Why on account of the lead-coated shot?—Because it could not stand quicker powder.

3842. Was it the lead coating or the vent piece, or what?—It was the lead coating.

3843. (*Major-Gen. Taylor.*) But by your account you get a longer range with a slow powder?—No.

3844. With a much smaller charge, with two pounds of powder less at Shoeburyness you get a range only 100 yards short of what you get with 12 lbs.?—Yes.

3845. Then you get the greatest range with the slow powder?

(*Col. Simmons.*) Did you mean 12 lbs. of the same powder.



(*Mr. McDonald.*) He got greater proportionate range. Beyond a certain point he got no proportionate benefit from the increased charge?—No, 2 lbs. extra of powder only gave 100 yards more range.

3846. What do you consider the proper charge for your 70-pounder?—12 lbs. if it were a quicker powder.

3847. (*Col. Simmons.*) What do you consider would be the proper charge with the Shoeburyness powder?—I think those experiments that I mentioned prove what I say.

3848. (*Major-Gen. Taylor.*) I took it the other way, that he could not get any corresponding additional range by increasing his charge. That is what you mean?—Yes. The question put before to me was, what did I consider the proper charge for my gun. I had considered 12 lbs. was the proper charge from experiments which I had made formerly, but when I came to have a trial at Shoeburyness I found that 10 lbs. of powder gave us within 100 yards as much range as 12 lbs.

3849. (*The President.*) Of the other powder?—No, of the same powder.

3850. (*Major-Gen. Taylor.*) Now I will complete the thing by asking you what proportion did the range, which you got with that Shoeburyness powder bear to that which you got with the other powder you used before?—You could not make the comparison very well, because the wind might be different.

3851. But *ceteris paribus* you know?—The range which I had at Southport with 12 lbs. of powder was 10,300.

3852. (*Col. Simmons.*) In firing at Southport was the gun nearly on the same level as the extreme range?—Yes.

3853. That decreased range might not have been due to the level between the point at which the gun was fired and the point of the break of the shore?—No, it was fired on the same level, on the sands. Then the proper charge I conceive of the other gun, the shunt gun, if mine was 10 lbs., would be 15 lbs.

3854. Why would it be so?—Because the area is half as much again. Therefore the strain upon that gun would be, of course, so much less than the strain upon mine.

3855. (*Mr. McDonald.*) Then, according to your view of the matter, the shunt gun has been, throughout these trials, firing 5 lbs. less charge each time than it ought to have been?—Yes.

3856. (*Col. Simmons.*) Before we leave the manufacture of the 12-pounder, I should like to ask a question with regard to the trunnion. Are the trunnions made in a solid block which is then bored out and the screw turned in it?—Yes.

3857. Of what metal is that?—These trunnions are the same as the other part of the gun, as our gun.

3858. It appeared from the trunnion that was broken at Shoeburyness by the striking of the shot, that that trunnion was of wrought iron, and not of homogeneous metal; that has appeared so from the chemical examination of that metal?—We have made them of wrought iron.

3859. But the gun at Shoeburyness that was delivered to us?—I expect that it was of homogeneous metal. We have generally made them of homogeneous metal. In some of the earlier guns we made them of wrought iron.

3860. The piece that was knocked off has been chemically examined, and it has been reported to the Committee that it is wrought iron and not steel, not homogeneous iron?—Yes.

3861. Then you make them sometimes of wrought iron, and sometimes of steel?—Yes.

3862. (*Mr. McDonald.*) You were under the impression that it was steel?—Yes.

3863. (*Col. Simmons.*) Are you making any quantities of these 12-pounders now for any foreign

Governments?—We are not making a great many of the 12-pounders.

3864. Or of any others?—We are making as many as we can.

3865. Captain Noble, when he was examined here the other day, acting for Sir William Armstrong, stated that he would be willing to lay before the Committee the prices of guns according to *bonâ fide* existing contracts upon which they are making them for foreign Governments; and would be willing, if you would do the same, to allow those prices to stand as fair comparative expressions of the cost of the guns as manufactured by the two systems. What do you think of such a proposition?—With reference to their manufacture, they have been engaged I think now for a considerable time, and they may consider perhaps that they have got the thing as good as it is likely they will get it. It is not so with us. I am looking forward to this great reduction in the price which I have mentioned, and a corresponding diminution in the price of the gun. I may mention, with regard to what I saw at Crewe, that steel rails last ten times as long as iron rails. Mr. Ramsbottom told me that when all the arrangements were completed, he calculated that the increased cost would only be 50 per cent.

3866. (*Major-Gen. Taylor.*) On the original rail, on one rail?—Yes; that the steel rails would last ten times as long as the iron rails, and would be only 50 per cent. more costly.

3867. (*Col. Simmons.*) The condition of the rail and the gun as regards constant wear and tear, is somewhat different. The rail is subject to wear and tear every day, and must be subject to it, whereas a gun is seldom used to such an extent as to bring it up to its life, if I may so speak, so as to test it by its endurance. The guns, as a general rule, remain for a great number of years, and there is a great pressure upon them; but it does not run to the extent it does with regard to the rails. Probably beyond a certain point, the comparative life is of very little consequence?—Then you see of what great importance it is, when the gun is wanted to do this extraordinary work, and if it is not able to do it, then, as the Americans have found out in their attacks on the Forts, the guns go bursting about their ears.

3868. Probably the number of rounds in those guns seldom comes up to 4,000 or 5,000 and even not half that, and therefore when it gets much beyond that number, the comparative life would appear to be of very little importance beyond what guns are subject to in warfare?—Yes.

3869. (*Major Young.*) Have you any very large guns made on your principle that have endured any very great number of rounds?—No; we have been making 7-inch guns for some time past.

3870. (*Col. Ormsby.*) The guns that you send to foreign countries, do you ever get reports of them afterwards if they go abroad?—Not generally.

3871. (*The President.*) Have you heard of any guns having gone which were supplied to foreign powers?—Not lately; there was a Danish gun which we supplied that burst.

3872. How many of them?—Only one.

3873. How long ago?—As near as I can remember three years ago; about that.

3874. Have you had any reports of any other guns having burst?—I think not. We have heard from time to time from the Confederates, but not direct of course. We have heard from time to time of the great successes that they have had with these guns.

3875. (*Mr. McDonald.*) Have you supplied any of the guns to the Egyptian Government?—Yes.

3876. Have you ever heard of them bursting?—No.

3877. (*Col. Ormsby.*) What sized guns were they, large guns?—I think a 32-pounder was the largest, and then there were 6-pounder guns. I had an order for a number of those guns by the late Pasha; but the present Pasha did not wish to have them, and there

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was an arrangement made with regard to those that had not been begun and they were not sent.

3878. (*Col. Simmons.*) Had you delivered any of them at the time that arrangement was made?—Yes. None had arrived out I think. There had been some delivered.

3879. Delivered in England?—Yes, I think so.

3880. I ask the question because it was stated to the Committee, the other day, if I remember rightly, that the Egyptian Government had ceased to receive your guns in consequence of the failure of some of them?—No.

3881. (*Col. Ormsby.*) A portion of them?—No.

3882. (*Capt. Wilson.*) Have you ever had any report from the Egyptian Government?—No. I do not believe anything of the kind.

3883. (*Col. Simmons.*) If none of them had been delivered out there when that arrangement was made that would be an answer to the question?—Just so. We had a quantity of machinery ordered at the same time, when the late Pasha was here; and waggons, travelling workshops, and the whole of the order was given up, with the guns and rifles as well, the whole thing. The late Pasha was a great fancier of guns and machinery.

3884. The whole contract was given up together, machinery and everything?—Machinery and everything.

3885. (*Col. Ormsby.*) Do I understand then that you have not delivered any large guns to the Egyptian Government?—No; not in Egypt, whether they ever had a 32-pounder delivered or not I don't know; but I think there was nothing larger than 6-pounders.

3886. (*Mr. McDonald.*) You are not aware of what the circumstances were under which the Danish gun burst, whether there had been any neglect in loading, or so on?—Yes; we have got evidence that the Danish officers in loading the gun did not allow the shot to go up to the powder, and that they believed it was a much better mode of loading the gun in that way, and that they got greater range thereby.

3887. By air space?—Yes; by having air space between the shot and the powder. We received a letter from a party quite unknown to us; I believe he was a representative of the press over there. He wrote us a long letter about it, and when Mr. Wain, the Danish Marine Engineer, came over he admitted that the gun was improperly loaded.

3888. (*Col. Simmons.*) It arose, not from the jamming of the projectile, but it was done on purpose?—Yes; by the shot not being put up to the charge.

3889. It was so loaded on purpose, and did not happen by reason of the accidental jamming of the projectile?—No; it was so loaded on purpose. They believed they got a greater range in that way. The gun had been fired for some days.

3890. What sized gun was it, do you know?—It was not larger than a 32-pounder. I think it was a 32-pounder.

3891. And when it burst, have you received any report as to the nature of the action, whether it burst into a great many fragments, or in what way?—It burst in several pieces; at that period we had not the mode of testing that we have had since.

3892. (*Mr. McDonald.*) You had not nearly the certainty in dealing with the metal which you have since acquired?—We did not know except by the proof of the gun; we had no means of knowing exactly what it would stand. I have no doubt, before long, that I shall be able, if I have a piece of metal given to me, by subjecting it to certain tests to say what charge of powder it is capable of bearing if made into a gun; but at that time we had no particular test.

3893. Passing on now from the manufacture of the 12-pounder to the manufacture of the larger description of gun, do you complete the bore before putting on

the additional thicknesses of metal?—We complete the bore after the hoops are on. In all cases in the 7-inch guns we have not completed the bore perhaps before the last series of hoops have been put on, where there is one more than there is in *this* [*referring to the drawing*].

3894. Will you describe the process by which you put on the additional thicknesses of the hoops?—The hoops are put on by hydraulic pressure. *This* [*again referring to the drawing*] is a regular taper.

3895. Is that taper uniform in all cases, is it the same for all guns?—No; it is not exactly the same. What rules the taper sometimes is the relative proportion of the gun; sometimes we are obliged to deviate a little.

3896. (*Major Young.*) Are the outer ones put on with the same taper as the inner ones, in the same kind of gun?—Yes, generally.

3897. (*Col. Simmons.*) Have you any fixed expression for the difference in diameter of one tube as it is placed on, in relation to the one within it, the iron within it.

(*Major Young.*) Or as to how much it is forced up?—Yes, it may be one in one hundred, one inch for instance in tapering a certain length.

3898. Yes; but how much is it forced up?—You mean how far is the press exerted?

3899. Yes?—Perhaps about three or four-tenths of an inch, according to the taper.

3900. Three or four-tenths of an inch in one in one hundred?—Yes, in length.

3901. Pushed on beyond the fit?—Yes.

3902. (*Col. Simmons.*) Do you consider that a preferable method of pressing on the hoop, to the method of shrinking it on?—Yes; the workmen must be more careful with reference to the sizes.

3903. So that you have a more certain knowledge of the strain that you bring on the material?—A more certain knowledge of every part taking up the same strain.

3904. Whatever may be the size of the gun, are all the hoops of the same material?—Yes, precisely.

3905. (*Major Young.*) And you prefer having even the trunnions made of homogeneous metal?—Well, in some of the guns that we are making. You see in *this* [*referring to the drawing*] the trunnion is homogeneous metal, because the trunnion takes the strain the same as the hoop. If we make the hoop of a different metal, a cheaper metal, we then make it larger in diameter, and retain the hoop.

(*Major Young.*) Just a surface hoop.

3906. (*Mr. Pole.*) I think that is the case with the 12-pounder, it does not seem as a strengthening hoop?—Yes.

3907. (*Col. Simmons.*) Have you ever observed in any of your guns that the barrel from the action of the shot, has turned within the hoop that surrounds it?—No, never.

3908. You have had no case of that sort reported?—No, never.

3909. Then you consider that the pressure that is brought upon it by this proceeding of forcing on the hoop by hydraulic pressure is sufficient to prevent any action of that sort?—Oh, yes! It is impossible I should say that it could happen, considering the strength of these hoops and the strength of the metal. If it was a very thin hoop, and of wrought iron, then I could understand it.

3910. I ask the question because it has been stated in evidence, I think before the Committee, that that sort of action had been observed in some former cases of guns, I think with the Armstrong guns that were first manufactured, the barrel has moved within the surrounding hoops, and I did not know whether such an action might not have occurred with yours?—I think that would happen if it was of iron, and the hoop thin.

3911. In the 70-pounder gun which has been delivered to the Committee it appears from the drawings



that the hoop, the next layer over the barrel is not in one piece but in three; are those pieces connected in any way [*pointing to the drawing*]?—These two are connected by that screw [*pointing to the drawing*].

3912. And the other piece, is that connected in any way?—No, that is not.

3913. Is that connexion, with the screw, made before it is forced on, it must be of course?—Yes, so that this [*referring to the drawing*] is one hoop.

3914. (*Major Young.*) Forced on at one time?—Yes.

3915. (*Col. Simmons.*) Have you made many guns upon that exact construction?—Yes.

3916. The succeeding hoop after that other appears to be also in three portions, is it not?—Yes. That is in one up to *there*; and the trunnion is screwed on to that [*pointing to the drawing*], and then this is not attached, it is loose. The pull of the trunnion is upon *this* [*pointing*].

3917. And then there is an extra portion put on afterwards; another hoop, I believe, that was added in consequence of the change in the position of the vent?—Yes.

3918. As in the 12-pounder?—Exactly.

3919. If the vent was made through the breech-piece would you consider that necessary?—No.

3920. And after the experience that you have gained from the experiments that have been made by this Committee, are you still of opinion that you would place the vent through the breech-piece in the axis of the gun in future constructions?—I should prefer to do so.

3921. (*Mr. McDonald.*) Would you state the mechanical reasons why you prefer doing that?—If the vent is through the centre of the breech, then the whole of the gun is precisely of the same strength; there is no inequality.

3922. (*Col. Simmons.*) It involves, does it not, a peculiar construction of cartridge so as to ignite; similar to that with which the Committee have carried on their experiments?—Yes; I think the ignition of the cartridge in the centre must be better than igniting it at the top; and perhaps more especially for gun cotton.

3923. The Committee have, in their experiments, as you are aware, experienced great difficulty from the vent in the breech-piece constantly becoming clogged or stopped from same cause. Would you still, after your experience in that respect, continue the construction in that way?—I think that that has been now remedied. I am not aware that for some time past there has been any inconvenience from the rear vent.

3924. (*Capt. Wilson.*) In order to prevent it, it has been necessary to prick the cartridge each time,

[The Committee then adjourned for a short time.]

3938. (*Col. Simmons.*) Do you apply the same proofs to the steel in the outer rings as you do to the steel in the barrel of the gun?—Yes.

3939. They are treated in precisely the same way?—Precisely.

3940. It was stated the other day to the Committee that the cost of the gun manufactured in this way with steel outer rings was very much greater than that of a gun made with a steel barrel, with wrought iron hoops superimposed?—Yes.

3941. If that be the case, do you think it of such importance to keep steel in the outer rings that you would prefer a dearer gun with the steel superimposed to the cheaper gun with the wrought iron superimposed?—It depends upon what you want the gun to do; if you are satisfied, as I said before, in the 7-inch gun, if you are satisfied for it to fire 10 lbs. of powder, you may have wrought-iron coils.

3942. You consider it an essential, to have the steel coil in order that you may have the full charge of powder which the gun can consume, is that what I am to understand?—Yes. My opinion is that you cannot

to pass the priming wire through the cartridge to prevent it?—So you do when it is ignited from the top.

3925. It is a very different thing. You see it requires with this vent piece a much more intricate operation than pricking the cartridge at the top, which is a very simple one?—The action of mine, I think, is much preferable, but of course it is for naval and military officers to decide which they prefer. As far as the gun itself is concerned, the rear vent is the best.

3926. (*Col. Ormsby.*) The only thing you would say is this, that if you got an order to make a gun with a top vent, you would put on that additional strengthening which you would leave out if it was a rear vent?—Yes.

3927. (*Col. Simmons.*) In the guns which you have sent out to foreign parts has the breech-piece been screwed in in the same way as the 70-pounder delivered to us?—Yes; we made them all that way.

3928. With screws of two different diameters?—Yes.

3929. Have you received any reports of your guns which have been used abroad. Have any complaints been made of that screw shifting?—No.

3930. It generally does move a little does it not?—It has done in some of our experiments at Shoe-buryness; but that to me was very satisfactory, that moving.

3931. (*Capt. Wilson.*) Up to a certain point?—Yes; because it shows that if we required to take it out we could do so. It is very easy to prevent its moving at all, by the simple insertion of a key.

3932. (*Col. Simmons.*) Do you think it is an advantage not to have a key there, so that in case of necessity you might remove it?—Yes; take it out.

3933. In the guns that you have sent to foreign parts have you generally had the vent in the breech-piece?—No; we have had the top vent.

3934. And have you always inserted a copper base to the bore?—Always; precisely the same as *this*, only with a top vent.

3935. (*Mr. McDonald.*) Why have you used a top vent in guns for foreign governments?—I wished to have the experience in these guns first.

3936. After the experience that you have had, would you use the top or the rear vent?—I very much prefer the rear vent.

3937. For these two reasons; first, of not wounding the barrel, and also for the convenience of drawing the vent tube?—The strength of the gun is not interfered with, and the lining of the gun has more endurance, it is less liable to any grooving.

have the gun too strong; because if you have plenty of strength in your gun, you have no occasion to have this half charge of powder, and you have no occasion to have it such slow powder: you may have a powder of which you can consume more if you have plenty of strength in your gun. And even more than that, we are now going on with experiments with gun cotton: and I have great faith in gun cotton. I think we shall get lower trajectories by using it than we do with gunpowder; I had some experiments when Baron Lenk was over, two or three years ago, and I was looking over my memoranda the other day and found that at 500 yards, I got a trajectory of 1° 12'. I was firing a fortnight ago with the rifle that has been so celebrated, the Prussian needle rifle; and the trajectory of that rifle is 2° for 500 yards.

3943. (*Major-Gen. Taylor.*) Which rifle is that?—The new Prussian needle gun, the rifle that was employed against the Danes. I have two of them, a carbine and a musket. This was a long musket.

3944. How did you fire that, with the gun cotton?—Oh, no! I am not speaking now of gun cotton. This

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was with cartridges that came with the rifle, and the elevation was  $2^{\circ}$  at 500 yards. The elevation that I got with gun cotton was  $1^{\circ} 12'$ .

3945. (*Col. Simmons.*) From the same gun?—No; one was my rifle with the gun cotton, the other was the Prussian needle rifle.

3946. (*Mr. McDonald.*) What is the elevation of your gun fired with the common powder?— $1^{\circ} 20'$ .

3947. And what with the gun cotton?— $1^{\circ} 12'$ . I was obliged to discontinue the experiments for want of gun cotton; but we are now going on again, so that I have no doubt, from the experience I have had with the rifle that we shall get lower trajectories with the guns by using gun cotton.

3948. (*Mr. McDonald.*) Then, in point of fact, if there was no other reason at all, for the sake of the future before us with reference to ammunition, you would be desirous of having the strongest gun possible?—Precisely.

3949. (*Col. Ormsby.*) Do you think there would be a greater strain on the gun fired with gun cotton than with gunpowder?—Well, there is something very remarkable in gun cotton with regard to the recoil; we may get, perhaps, a trajectory quite equal to what we get with the best gunpowder, with less recoil than we have with gunpowder. Then suppose that should turn out to be the case, you will see the great importance of having immense strength; because if you have not so much recoil, instead of having the 7-inch gun 7 tons weight, we can do with less weight with gun cotton. But then we want greater strength.

3950. (*Col. Simmons.*) But if it is merely a question of weight to check the recoil would you adopt the expensive material of steel?—No, certainly not. Only we should not want the weight.

3951. (*Mr. McDonald.*) You would use steel for strength and not for weight?—Undoubtedly. If we have less recoil we may diminish the weight; but still we want great strength for gun cotton.

3952. (*The President.*) It was mentioned to us in evidence the other day that the Russian Government had been compelled to abandon the use of Krupp's steel for guns, and that also the Danish, Egyptian, and American experiments had all a tendency to induce those Governments to give it up?—Krupp has made his guns solid. Now certainly I would not make a large gun in one solid mass. Krupp does that.

3953. (*Mr. McDonald.*) Why. State your reasons?—Because in the large mass, you are more liable to unsoundness than you are in the smaller mass. And if you get unsoundness in one of these large guns, if it is composed of different layers; if you have got a flaw in one it does not affect your gun in the same way.

3954. (*Col. Simmons.*) Are Krupp's made solid?—They are made solid. He does not hoop them.

3955. (*Mr. Pole.*) At any rate, in regard to preferring built-up guns to solid guns, you and Sir. Wm. Armstrong agree.

3956. (*Col. Simmons.*) In the larger guns, according to your system, are the barrels, cast solid or hollow?—I have had them done both ways, as I have mentioned.

3957. Beyond a certain point, you have not any rule to make them hollow, have you?—No.

3958. If you were to make a 15-inch gun would you make that solid or hollow?—I should make that hollow, I should not dream of making a 15-inch gun solid.

3959. The 10-inch gun, would that be solid or hollow?—I think that would be best cast hollow.

3960. (*Mr. McDonald.*) To what point of certainty is the manipulation of steel arrived, as expressed in the size of the gun. What size of gun would you feel confidence in undertaking with your present knowledge of steel as a material?—We have a 9-inch gun just finished, in which we have every confidence, weighing about 16 tons.

3961. (*Col. Simmons.*) Is the limit of the steel that can be manufactured sound, the weight of the ingot?—In the case of the hoop system, however large it is, you have not that great mass that you have in the case of the solid guns, as Krupp makes them. The air gets away better, and you have the core; you are not so liable to unsoundness.

3962. Is there a limit in the weight of the ingot up to which you could make it sound?—No, I think not; on this built-up principle, no limit. You could make a gun of 3-feet bore.

3963. What is the weight of the solid projectile of the 9-inch gun?—320 lbs.

3964. That is the largest you have as yet attempted to make?

(*Capt. Wilson.*) That is the solid shot?—Yes.

3965. (*Major-Gen. Taylor.*) Have you ever estimated at all the extent to which you could go in making heavy guns, supposing future experiments should show that for certain purposes, such as breaching in the sides of ships, a large calibre was of great value; have you any materials for saying to what extent you could go in the manufacture of large guns?—I do not think there is any limit.

3966. About the barrel in the first instance; do you think you could get material of sufficient size?—I think there is no difficulty about it, with the hoops.

3967. About the barrel; you must have a barrel of very large scantling?—Yes; but you do not cast it solid, you cast it hollow.

3968. (*Major Young.*) Still you have not had great experience of that?—We have had experience in these 9-inch guns.

3969. (*Mr. McDonald.*) You are against the larger sizes as a rule?—I have no hesitation in saying that this 9-inch gun of ours at 2,000 yards will send at shot through the side of any ship afloat.

3970. Your theory is that the smallest gun that will do the work is the best?—I do not see why you should use a larger gun than is necessary. In the case of shell I would increase the length. I do not see any reason why you should not fire shells, of five diameters long, if you get a rotation sufficient.

3971. (*Major-Gen. Taylor.*) Don't you attach any value to the knocking of a large hole in a ship's side at sea. The smaller holes can be plugged, especially if they are cut by a shot at high velocity?—A 9-inch hole would not be easily plugged if it was a shell. I should have no idea of firing solid shot.

3972. The action of shells would be in-board?—Yes.

3973. I am putting the case, assuming it to be decided that it is an object to knock a very large shattering hole in a ship's side, and that guns of a very large calibre should be desired for that purpose. Could you, with the knowledge you have of this material, undertake to make these guns of large calibre?—Yes; but I would prefer to have two guns of 9-inch bore, than to have one of double that weight.

3974. But then these two 9-inch guns would not make the large hole that I proposed?—They would make two holes.

(*Major-Gen. Taylor.*) They would make two holes which could be plugged.

3975. (*Mr. Pole.*) What is the maximum charge of powder you propose for this gun?—It would depend upon the trial. I would use as much as it would consume.

3976. Forty pounds?—It might be about that. I should make a similar trial to what I have made before, to see what it would profitably consume. With regard to this  $5\frac{1}{2}$ -inch gun, it is no use firing it with 12 lbs. of that powder, when the extra 2 lbs. only gives an extra 100 yards' range.

3977. (*Col. Simmons.*) What is the weight of that 9-inch gun?—Sixteen tons.

(*Mr. McDonald.*) Do you happen to know what the calibre of the 12-ton 300-pounder in the service is?

(*Major-Gen. Taylor.*) 10-3.



3978. (*Major Young.*) No; 10·5. What is the weight of your projectile in the 9-inch gun?—320lbs.

3979. What principle of rifling do you use in that gun; a lower pitch, I presume, than in the others; not the same angle?—Yes, the same proportion; the same angle.

3980. (*Mr. McDonald.*) You retain your pitch, your proportion?—The same angle as in the others.

3981. You don't let down your angle of rifling?—No; I would rather increase it.

3982. Is your pitch in the 70-pounder the same as in the 12-pounder?—Yes.

3983. (*Capt. Singer.*) It was stated last day before the Committee that the present price of a gun might be fairly estimated by the price of the material of which the gun was made. Is it your opinion that that is the case; that the manufacture may be considered equal as to Armstrong and Whitworth guns; the price of the manufacture. I mean the present price of the gun; I do not mean what it would be in six months time. The cost of the manufacture being about equal, the relative price of the gun may be fairly considered to be judged by the cost of the material.

(*Major Young.*) Is it fair to assume that?—In what stage do you reckon the value of the material for the wrought iron; do you reckon it when it is in bar, before it is coiled or after it is coiled.

3984. Before. It was mentioned on the last day before it was coiled or worked up at all?—You see we receive the material in the shape of a hoop, therefore the material is not delivered in the same shape in both cases. They get it in the bar, and my material is in the shape of a hoop.

3985. (*Capt. Wilson.*) You pay more originally?—Yes.

3986. Captain Singer said, assume that the material is the same price.

(*Capt. Singer.*) No. It was stated on the last day that the relative prices of the guns might be considered as to the cost of the material, not the work; the work was said to be equal in both cases. Mr. Whitworth is not of that opinion, because he says, his raw material is received in a different form to that of Sir William Armstrong's?—Precisely.

3987. (*Mr. Pole.*) You would compare your material as you receive it with the material as coiled?—Yes.

(*Mr. Pole.*) We have had the price of that, so that we can easily compare it.

(*Major-Gen. Taylor.*) The coil completed?

(*Mr. Pole.*) The coil completed, but not bored and turned.

3988. (*Major Young.*) Don't you find that steel is a much more difficult material to work than wrought iron?—It is a much nicer material to work; but you cannot run at the same speeds.

3989. Just so; more money is spent in wages in turning out a good bore in a steel barrel than would be in turning out a wrought-iron barrel?—Yes.

3990. (*Mr. McDonald.*) But I suppose as they get more perfect in the manipulation of the hoops they will send you less to cut off?—Less to turn off.

3991. There is no reason why any advantage which the coil process may have in giving you a thing to which there is little to be done should not be equally possessed by the hoop process?—Certainly; there should be no more to be turned off in the hoop process than in the coil process. On the contrary, I should take more pains with the steel, so as to turn less off, than with wrought iron.

3992. (*Col. Simmons.*) Do you consider that there would be any difference in the expense of putting on the outer coils in the two processes of putting on by shrinkage and putting on by hydraulic pressure, as you do, or might the two be considered to be about the same cost?—I do not think there would be any very great difference.

3993. The Committee have had a large quantity of ammunition delivered to them for these experi-

ments, do you think that the expense to the Government of the ammunition may be taken as a fair criterion of what the expense of providing ammunition in future will be?—Certainly not.

3994. Can you give us, for your 12-pounders, what would be the cost of the various descriptions of projectiles delivered in large quantities, or the items by which we can arrive at the cost of those projectiles?—As I said before, I think that if you want to compare the cost of the projectiles according to the two systems, there is no plan you can adopt so good as taking the actual time spent upon the different processes.

3995. (*Major-Gen. Taylor.*) Irrespective of the cost of the material or anything else?—Irrespective of the cost of the material or of the rate of wages paid.

3996. (*Col. Simmons.*) But in the lead-coated projectile, if the lead is put on by chemical process, the time alone will not give us the cost of that process?—You would have to add the lead.

3997. The lead and the fuel and other chemical ingredients?—If you take the cost of the material. The great element of cost of course is the time; but if you mix up that with the wages and so on, then you will get into difficulties. Now, for instance, in minding a machine, we pay a young man, when he first comes to us and has to learn, perhaps a  $1\frac{1}{2}d.$  an hour; then he gets up to  $1\frac{1}{2}d.$  an hour, and then up to  $2d.$ , and so on. Some of our men get  $5d.$  an hour; so that you can see it would make a great deal of difference. The rate of wages might be in the one case four or five times what it was in the other; so that if you eliminate that altogether and take the absolute time spent on each process—

3998. That alone would not do, because you must consider, according to what you say, the skill; the higher rate of wages follows the higher skill, I presume?—You can form a judgment upon the probable rate of wages, according to the difficulty that there is in the manipulation.

3999. So that it will not do to take time alone, you must take the skill of the persons also whose time is employed?—There would be very little difference, probably, in that.

4000. (*Mr. Pole.*) To take time alone would not only exclude the difference between skilled and unskilled labour, but it would exclude the difference between the expenses of the machines. Now I can fancy one machine of a very expensive kind being required to make the projectile, and another which would be very expensive to work?—No doubt the cost of the machine would be an element. The cost of the machine, the cost of the labour, and the cost of the material.

4001. Then would it not follow that the time alone would hardly be a fair measure for the cost of the projectile?—I think that will give you the best comparison that you can possibly have, the element of time.

4002. (*Col. Simmons.*) In the manufacture of a very large quantity of ammunition would not the cost of the machinery become very small when divided among the number of projectiles manufactured?—Yes.

4003. (*Major-Gen. Taylor.*) It would be an infinite series. Every addition to the order would be a diminution of the cost of the machine?—Yes.

4004. (*Col. Simmons.*) Can you give us the times as you have them of the different processes in the manufacture of your projectiles?—No; I should prefer the Committee taking them themselves.

(*Major-Gen. Taylor.*) I can see exactly what Mr. Whitworth means. Suppose we will say that he had a very expensive instrument. Up to a certain point he could say how much, if the number of rounds of ammunition to be furnished was finite; he could say what the cost of them would be including the cost of the machine. But if you get a contract that

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is to go on over an indefinite period, you have to spread the first cost of the machine over such an amount of ammunition that it amounts to almost nothing.

(*Col. Simmons.*) If the point to be arrived at is what would be the relative cost of the two if made by Government, I think one might probably eliminate the question of machinery and set that on one side altogether. Because the cost of the machinery divided among the quantity of ammunition which would have to be made by Government to keep up the Government supplies over a great number of years would be very small supposing the Government were to set up a factory to make it.

(*Major-Gen. Taylor.*) I do not see why we should not take it out altogether, merely keeping it in view as a question for the Government. For a definite number you must unquestionably take the machinery into consideration, but when it comes to supplying the country, it is another matter.

(*The Witness.*) I will take a projectile, and in the first place I will show you the projectile moulded. Then it goes to the shaping machine and is made ready to go into the gun, and you see exactly with your watch what time it takes for the whole process. You can form an opinion, but I do not think if you mix up the question of price with it, that you would be able to do so.

4005. (*Major Young.*) After that you can add the other things, taking them for what they are worth?—Yes.

4006. (*Mr. McDonald.*) After all, the Committee must form its own opinion upon it. It is a matter of opinion, it is not a matter that you can get at in any other way?—There is no mistake about a watch, it is the way I did in America, and saw what their machinery would do in the case of the machinery for making rifles. I took out my stop watch, and I timed each process by the watch, the number of seconds to each process.

4007. (*Major-Gen. Taylor.*) Is that the machinery in use down at Enfield?—Yes; you make an allowance for a man, if you watch a man doing it. Of course you say he will not be able to keep up to this, but you keep him up to it as far as you can, by giving him piece work. All men do the best they can when you are watching them.

4008. (*Mr. McDonald.*) On the subject of steel projectiles, I should like to ask you a question. When did you first use steel projectiles of homogeneous metal?—The first that we used for armour plates. I had made a number of experiments with the rifle in 1857; the first large projectiles we used was, I think in October, 1858, against the "Alfred." That projectile was made of homogeneous metal hardened in the same way as they have been since used. That was the first, in October, 1858.

4009. Subsequently to that time, do you recollect whether wrought iron was or not used as a material for making projectiles for similar purposes?—Yes; wrought iron was used after that.

4010. What became of the use of wrought iron for that purpose?—They tried wrought iron, but of course they were never able to penetrate with it.

4011. I suppose you would consider that a fair illustration of the advantages of the two metals?—I think so, and I believe more than that, that shot have been tried, wrought-iron shot, steeled, but they will not penetrate unless you have an enormous force. Of course you could send a wrought-iron shot through an armour plate, if you could only get the shot big enough.

4012. Or even cast iron?—Yes; even a cast-iron shot, if you could get it big enough.

4013. (*Major-Gen. Taylor.*) There would be always that difficulty attaching to the wrought-iron shot, of its setting up?—Yes; but practically wrought-iron shot is of no use whatsoever. I remember telling the Duke of Somerset when we penetrated the "Trusty";

we sent I think four shots through the "Trusty." I said I had no doubt from what I saw, that I should be able to make shell go through. That created immense surprise. They had no idea that such a thing could ever be accomplished as sending a shell through armour plate.

4014. (*Mr. McDonald.*) Then I suppose as soon as you succeeded in producing the shell, your example was speedily followed by other people?—Oh, yes.

4015. (*Captain Wilson.*) Your steel projectile in October 1858 was the first?—Yes, it was the first.

4016. The first that had been tried by any one?—Yes, at 450 yards, the first shot that we fired went through.

4017. They do make your projectiles I believe at the Arsenal at Woolwich?—No; they have not made provision for doing so.

4018. (*Col. Simmons.*) It would be only necessary to furnish a mould in order to enable them to cast them?—I think in order to form a fair comparison, you ought to see the processes in as perfect a state in both cases as you could see them. Of course Elswick would have the advantage over myself in that respect, because there are so many more men, and they have done so much more than what we have. But I should be quite content to have the comparison made.

4019. At Woolwich?—No; at our own establishment. In the case of the shunt, I am not aware whether they have got the requisite machinery for making the shunt projectiles at Woolwich, I should hardly think they had.

4020. (*Major Dyer.*) They can make them all three, and yours too?—They have not got the proper machinery for making ours, and I think they have never cast them at Woolwich. Are you aware whether they have cast them?

(*Major Dyer.*) Oh, yes! cast them and made them.

(*The Witness.*) The shunt?

(*Major Dyer.*) Yes, everything.

(*The Witness.*) Do you mean to say that at Woolwich they have cast our 12-pounder or 70-pounder shot with the rifling upon them?

(*Major Dyer.*) Oh, yes! they have cast them, and then put the rifling on them by tools.

(*The Witness.*) That is not the way we do it.

(*Col. Simmons.*) If you would let them have a few moulds, they could do it very easily.

4021. (*Col. Ormsby.*) Supposing you had a large Government contract, would you undertake to contract for so many shot or shell able to be fired, at the cheapest rate, without tooling?—We can fire them; we have fired them, as you know.

4022. I know; but I mean to say in case of war, and so on, if you had a large contract would you undertake to supply shot to the Government without tooling, from the casting?—Certainly, if they wished it.

4023. It would be a great deal cheaper, would it not, that way?—No.

4024. Would it be cheaper tooling?—It is better to tool.

4025. Would it be cheaper?—No; it would not be cheaper, but it would be better.

4026. (*Major-Gen. Taylor.*) What is the cost of making 12-pounder shot?—The 12-pounder shot, I think, are 5*d.* per dozen for tooling.

4027. (*Col. Ormsby.*) Do you cast all your shot and shell with the rifling on them?—All, except the 1-pounder.

4028. (*Major Young.*) I thought it was cheaper the other way?—No, there is so much metal cut away. We mould them just as easily with the rifling cast on as we should the other way.

4029. (*Col. Ormsby.*) There is an immense deal of labour saved by that afterwards; surely there must be less labour?—I would undertake in one day to show the Committee what they would want as far as



the ammunition is concerned, with regard to the shot and shell.

4030. (*Major-Gen. Taylor.*) I think it would be a very simple way to obtain that result, to go down to Manchester and see it?—Yes; it is the only way by which the Committee could be certain of having the thing ascertained satisfactorily.

4031. (*Col. Simmons.*) Then as regards fuses, do you make them yourself?—We have commenced to do so now. We have not sent any out; we have just commenced.

4032. Do you make them of the same form that Colonel Boxer invented?—We have commenced to copy Colonel Boxer's time fuse, an exact copy. We have nothing to offer in the shape of fuses.

4033. (*Captain Wilson.*) You are beginning to experiment and to test them for yourselves?—Yes.

4034. And of course you intend to send them abroad with your guns and projectiles?—Precisely.

4035. (*Major-Gen. Taylor.*) The material that you use for casting your shells, is it not the common cast iron of commerce, or is there anything peculiar in it?—No; it is cast iron.

4036. Have you ever found in any experiments which you have made as to the bursting effects of your shells, any marked distinction between the breaking up of the shells referable to their length; do you find that dispersing the charge over a shell of considerable length produces proportionate results to those that you have found with a shorter shell?—I think so.

4037. You have not found a tendency in the longer shell to break up into fewer portions?—No; the relative proportion is pretty much the same in the two.

4038. For the work done with the powder, you think the proportion would be the same?—Yes, the same.

4039. (*The President.*) Would you prefer to use a different kind of powder to that which has been used hitherto?—Yes, a stronger powder.

4040. For what reason?—In order to get greater penetration and longer range.

4041. (*Mr. McDonald.*) I suppose that is the reason why you applied in your last experiment against the armour plates to use the powder used for the smooth bores?—Yes.

4042. You wanted to have a stronger powder, and you thought that would give you it?—Yes; I did not know how much stronger that was, but I presumed the smooth-bore powder was stronger, and therefore I made choice of it for the penetration of the armour plates.

4043. (*Col. Ormsby.*) Do you prefer to fire your guns with a much quicker powder than the A 4 powder that we have been using?—Yes; in order to get more penetration.

4044. (*The President.*) And greater range did you say?—And greater range.

4045. What would be the difference in range do you suppose that you would obtain by using different sorts of powder; what increased range would you anticipate?—I can only give you facts.

4046. Well those are better than anything else?—At Shoeburyness we got 9,600 yards, and at Southport we got 10,300 yards.

4047. With the same weight of powder?—Yes.

(*Mr. McDonald.*) I thought you had been able to use 12 lbs. at Southport?

4048. (*The President.*) That was the same powder?—With 12 lbs. of powder at Shoeburyness we got a range of 9,600 yards; with 12 lbs. of powder at Southport we got 10,300 yards.

4049. (*Capt. Wilson.*) And you found that with 10 lbs. you only got 100 yards less range?—Yes; at Shoeburyness.

4050. (*The President.*) What you used at Southport to get that range was a stronger and a quicker

powder?—I presume it was; in fact it was how I came to determine the best weight of powder for my gun by these experiments at Southport.

4051. (*Col. Ormsby.*) Did you ever fire with the old powder, the L. G.?—Yes.

4052. (*Major Young.*) You did in one experiment at Shoeburyness, when you asked for it?—Yes; it was when we were unsuccessful in piercing the target at 400 yards; all the four shots went through.

4053. Wherever you want work you prefer using the strong powder?—Yes, certainly; that is the advantage of having a strong gun.

4054. Have you seen any large guns fired with gun cotton ammunition?—No; I have only used it for the rifle.

4055. (*Mr. McDonald.*) I understand that everything you have done in this matter has sprung from the small arm?—Precisely.

4056. The use of steel and everything?—Certainly, everything I did I tried first with the small rifle. I fired through water, I bored holes through wood, I penetrated steel plates, everything I did with the rifle first.

4057. You satisfied yourself with the small rifle first?—Yes, precisely; and then I worked it all through, beginning with the 1-pounder.

4058. (*Col. Simmons.*) I think, Mr. Whitworth, in the evidence you gave before the Committee some time ago you stated that you expected much better results from the use of compressed powder, have you made any experiments since which would tend to confirm you in that opinion?—Not since. With the rifle I used compressed powder, and I used gun cotton along with compressed powder, and obtained very good results from the combination of the two.

4059. (*Major-Gen. Tylor.*) What! gun cotton in combination with compressed powder?—Yes.

4060. Did not you find the explosion too rapid?—No. And gun cotton with loose powder.

4061. Did you find in using gun cotton with compressed powder that the explosion was simultaneous?—I had good results.

4062. I am surprised at that, because generally you can explode loose powder in your hand without touching gun cotton at all?—If you can commence your explosion with the powder, and start your shot and then follow up your explosion, you get a good thing with much less recoil.

4063. (*Colonel Ormsby.*) It would be severe work for the gun?—No. I would in all cases take all out of a gun that I dared, you never can get too strong a gun. I am convinced of that.

4064. (*Mr. McDonald.*) The strength of the gun is the fundamental principle in your opinion. It lies at the basis of everything else?—Undoubtedly, you cannot make it too strong.

4065. Without it you can do nothing?—Precisely. That and economy of projectiles.

4066. Those are the cardinal things?—Yes.

4067. (*The President.*) But has it not been found by experience that your barrels turn round and spike themselves?—We never had an instance.

4068. I am told that it appears from a report of General Gilmore's, in which he states that the Parrott guns were superior to the Whitworth, from the fact of your barrels turning round and spiking themselves?—Never.

(*Major-Gen. Taylor.*) We have never had any name given to it, but we have heard that story about "The Swamp Angel."

4069. (*Colonel Simmons.*) The question I asked Mr. Whitworth had reference to that very point. I had forgotten the circumstances, but I had heard that the barrel of the gun had by the action of the shot been turned so that the vent in the barrel was no longer opposite the vent in the coil, and therefore the gun as it were spiked itself; and I asked Mr. Whitworth if he had any knowledge of the barrel of any gun of his having turned in its outside jacket. I

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think Mr. Whitworth's answer was no, that he had never heard of such a thing?—Never. I do not believe it possible.

4070. (*The President.*) I think it right to mention such things as may have come out before the Committee, because if they should appear hereafter without any contradiction on your part, they may be accepted as established facts?—I am much obliged to you. In the same way it was always predicted that the shot being made of hard metal would wear out the bore of the gun. But now, what is the fact? we find that there is no wear with the shot in the gun, positively no wear, after it gets a certain distance. And one can only account for it in this way, that the shot rides upon the fouling; that there is a coating of fouling formed every time, and that the shot rides upon that. With our measuring instruments we are able to measure very accurately to the 5000th of an inch, and there is no wear in reality.

4071. (*Mr. McDonald.*) Was not it also predicted that the shot would jam?—Yes; that the shot would jam, and that the metals would adhere to each other, and that it would be quite certain to wear out the bore.

4072. (*Colonel Simmons.*) Do you consider then that in your guns your shot dispenses with lubrication?—Yes.

4073. And you would not anticipate any undue wear from firing a considerable number of rounds without lubrication?—From the experience I have had, I would propose instead of the lubrication we have had to use a very stiff oakum wad so as to prevent the rush of the gases through the windage of the shot. We find the greatest wear of the gun is in the powder chamber, and over the shot, where the gases get through the windage. Now, if we had a good stiff oakum wad put in, that would prevent, to a great extent, the rushing of the gases.

4074. (*Col. Simmons.*) Is that suggested to you by the experiments that have been conducted before this Committee?—Yes.

4075. Would that oakum wad carry any lubricating principle with it?—I do not think it is necessary.

4076. You propose it, then, merely to prevent the gas rushing over the projectile?—Yes; through the windages of the shot, and so wearing the gun. I found in the first thousand rounds of the 70-pounder gun, I do not know whether you are aware of this, that the wear of the powder chamber was the 100th of an inch for the thousand rounds.

4077. The 100th of an inch of expansion?—Yes; in diameter it had got that much larger by being worn away.

4078. Was it worn away by friction, or was it by expansion?—I should think it was friction; not expansion at all.

4079. Regularly worn away?—Yes.

4080. (*The President.*) Was it evenly worn away?—Yes, pretty evenly; the 100th of an inch to the thousand rounds.

4081. (*Col. Simmons.*) In your opinion, was none of that due to expansion?—I should think not; I should think that the strain upon the gun is such that it all comes back. There is no permanent alteration.

4082. Do you think that any of it might be due to the compression of the metal in the barrel within the hoops?—I think not. It would only make for 10,000 rounds the 10th of an inch.

4083. According to your measurement, by those delicate instruments which you have at your command, do you find that same result going on proportionately as the number of rounds is increased?—Well, I cannot say; we shall know. As these experiments are going on for endurance, I am having it measured. It is only in consequence of this prolonged investigation before the Committee, that one is enabled to obtain these important results.

4084. (*Col. Ormsby.*) What would be the greatest degree of wear a gun would stand before it would

burst, do you think. You say that the result is the 10th of an inch in 10,000 rounds; what would be the greatest extent it would go to before the gun would burst?—I really cannot say; it would be the 10th of an inch in 10,000 rounds, but might go on a little quicker as the surface got very much rougher.

4085. I want to know how much, in your opinion, the gun would stand before it went?—There is no estimate so long as you have not a force greater than the metal is able to bear. That is the advantage of having a metal so much stronger than what you want; if you do not disturb the particles, there is no permanent alteration taking place, and it is like a beam or girder, or anything of that kind; it will go on lasting any length of time.

4086. (*The President.*) What would be the test that would be given by which you could discover when it was about to burst. What evidence would it give that one might expect to see?—What has happened in the cases where we have had improper loading, for it is only in the case of straining the gun, as happened with the rifle, it bulges.

4087. (*Col. Simmons.*) But does not break up?—Does not break up.

4088. (*Col. Ormsby.*) I think you said there was a gun went to pieces in Denmark?—Yes; but we do not know what that material was.

4089. It was made by you?—Yes; but it was made before we made use of tests. It was in consequence of having these misfortunes at the commencement that led me to institute these tests. Now I never make a gun without having proved the material.

4090. (*Col. Simmons.*) Do you find much inequality in the wear of the barrel caused by the rush of the gas, through the windage of the shot in different barrels?—As to that, we have only your experiments to guide us.

4091. You have no other experience?—No; it is a very great pity, instead of experimenting with such a great number of guns as they continually do with the different sorts of riflings, which really means nothing, that they do not have some carefully conducted experiments with one gun so as to watch all these points, the whole thing might be settled at once. I consider that these experiments, which are being conducted before the Committee, are most valuable ones; they enable one to form a correct opinion.

4092. (*Capt. Wilson.*) Do you mean that different kinds of rifling mean nothing; or that different degrees of rifling with a different spiral?—Well, those are points that want to be carried out in order to satisfy the Committee. I have satisfied my mind; but then there was no one present. With regard to the wear of this gun, they should go on firing it so many rounds a day till something came of it.

4093. Until the gun became useless, in fact?—Yes; and take the measure every week or every 500 rounds.

4094. Yes; but our object of course is to try other systems of rifling too?—Well, that is merely a question of expense. But one system of rifling, if it is properly made, will produce as good shooting as another. It is a question of economy. I maintain there is no other mode that can be adopted as cheap as the polygonal system.

4095. Taken in connexion with the projectiles?—Yes.

4096. (*Mr. McDonald.*) The projectile is the thing that governs the question of cost, according to Mr. Whitworth?—Yes. As regards the system of rifling the gun, the cost is comparatively nothing. It is the projectile.

4097. (*Capt. Wilson.*) You consider you have set the question at rest by your experiments. You have satisfied yourself?—Quite; and the thing is now in the year 1865 the same as I had it in the year 1860.

4098. (*Col. Simmons.*) Are the steel projectiles which you have made for the penetration of armour



plates, the same description of steel as that your guns are made of?—There is a little more carbon in them.

4099. Do you prepare them yourself?—Yes.

4100. Are they hardened and tempered after they are turned?—Yes, after they are made. We harden and temper them in a different way to what we do the guns. They are harder; they would bulge up if they were made of the same material as the gun, the same temper as the gun. The four shells that I fired last against an armour plate at 600 yards, which went through, I think was a pretty good proof of the sort of material that we could make when we tested it properly.

4101. There is one point that you mentioned with regard to the tempering of the steel of the gun itself, upon which I should like to ask you a question, which is, what guarantee have you that the quality of the steel in the barrel after it is made up will fully equal that of the portion which you test. Because you cut off a portion, and apply your process of hardening to that small portion, and then test it; and then you trust, as far as I understand, to the workman to bring up the gun to the same temper as the small portion that you tested?—Yes.

4102. But what guarantee have you that they do actually in practice produce the same effect upon the barrel which they have upon the small portion?—We have no guarantee; only we have intelligent men who superintend and look after the thing.

4103. And the application of the process depends upon the skill of the man, and not upon any absolute measurement of a thermometric nature?—No; because time is an element as well as the degree of heat.

4104. The time in cooling?—And the time in heating also.

4105. (*Major Young.*) Do not you think that a percussive action is more injurious to steel or to homogeneous metal than it would be to wrought iron, a blow I mean?—No; not if it is properly tempered. We have proved all that in the bulging of the barrels. If you were to make a barrel of cast steel, of course it would be more injurious; then it would fly into pieces; but if the metal is made of the right temper it is not so injurious as it would be to wrought iron.

4106. (*Col. Simmons.*) In fact, the whole value of the steel depends upon the temper and the treatment?—Yes.

4107. (*Mr. McDonald.*) It is a question of treatment in fact?—Exactly; it is the same as getting a good or a bad razor.

4108. And that treatment, as you maintain, has now reached a greater degree of certainty than the treatment by which the corresponding qualities of wrought iron are brought out?—I think so; it has come to that; the melting process is a more certain process than the puddling.

(*Mr. McDonald.*) That is the point as it seems to me. Mr. Whitworth contends that it is a question of treatment, but that the treatment now gives more certain results for steel than the treatment to which wrought iron is subjected, and upon which it depends for its qualities, yields.

(*The Witness.*) At least we are coming to that. In brass casting, in cast iron, and in all the melting of metals we have more certainty than we have in the puddling of wrought iron.

4109. (*Major-Gen. Taylor.*) Do not you think, Mr. Whitworth, that in the event of a war and of a very heavy demand coming for a supply of guns there would be considerable difficulty in procuring for a long time the material you require for your guns in the great quantity that would be demanded, of the same reliable nature, that you can get now in smaller quantities? Do you think it is a manufacture which has developed itself sufficiently rapidly to meet an increased demand?—Certainly, to any extent. I suggested some time ago to our naval authorities,

seeing the great change that they would have to meet in supplying new armament, that all our marine establishments might easily, with very few extra tools indeed, be made available for producing guns, with very few alterations.

4110. Not for the manufacture of guns?—Yes. Most of the tools they now have would come in, so that in the case of a sudden and very great demand all the marine establishments might make them.

(*Col. Simmons.*) I think General Taylor's question had more reference to the production of material than to the actual building up and making of the gun.

4111. (*Major-Gen. Taylor.*) Yes; whether you could obtain a sufficient supply of the homogeneous metal of that character?—Yes; because all the works and furnaces exist in Sheffield for the manufacture. It is only that when once you have the knowledge of what you require in the mixing of the metal all the works exist for the production of it. All existing steel works are available for the manufacture of this metal.

4112. (*Col. Ormsby.*) Are the ores from which the metal is manufactured entirely British, or some foreign ores?—Foreign ores made with charcoal.

4113. (*Mr. McDonald.*) Is there a sufficient supply of these foreign ores?—Yes.

4114. Where will those supplies principally come from?—Principally from Sweden and Russia.

4115. Is that Spiegeleisen ore used much, that German ore?—Yes; there is a little of it used.

4116. But there are ores in this country that are used to some extent, also, are there not?—Yes.

4117. The hematite ore of Cumberland?—Yes; the best Bessemer material is chiefly made from hematite and Spiegeleisen.

4118. (*Col. Simmons.*) But is the steel in your guns made from any special mixture of your own that is not used by anybody else?—Yes; we are now coming to that. In fact, it was in consequence of Firth's not wishing to reveal their process that I was induced to commence the manufacture.

4119. But are these 70-pounders that the Committee have been experimenting with made with steel that other people cannot produce, or made with such steel that Sir William Armstrong or anybody else can purchase from Firth?—Yes; that anybody can purchase from Firth.

4120. (*Major Young.*) In fact, we have not had any of your best metal?—No; you have not had any of the metal made by us.

4121. (*Mr. McDonald.*) Except for projectiles?—No, we have not sent you any made by ourselves.

4122. Not even shells?—No.

4123. (*Col. Simmons.*) Are your steel works established now so as to make steel in any large quantities?—No, not in large quantities, about 500lbs. weight.

4124. In large masses?—No; not in large masses; about 500lbs. weight.

(*The President.*) Has any other member any question to ask Mr. Whitworth?

4125. (*Major Young.*) With regard to the cost; we asked you the price at which you were supplying these guns and projectiles to foreign governments, and you told us that that would afford no criterion for estimating the cost as compared with Sir William Armstrong. Would you have any objection to tell us the particulars of any contract of that kind?—No; we will supply you with the contracts that we have made.

4126. (*Colonel Simmons.*) With the prices of *bonâ fide* existing contracts?—Yes.

4127. (*The President.*) I think it was stated before us the other day that the difference in price between your guns and Sir William Armstrong's was as 1,600*l.* or 1,700*l.* to 3,000*l.* The words are these: "We sent in our contract and Mr. Whitworth sent

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" in his, and our price was 1,600*l.* or 1,700*l.* and  
" Mr. Whitworth's was 4,000*l.*" ?—We have sent in  
no prices for guns of that size at all.

4128. (*Major-Gen. Taylor.*) Those were both 12-  
ton gun ?—That is some mistake ; we have not made  
a 12-ton gun.

4129. (*Col. Simmons.*) Will you send in to us  
prices of existing and *bonâ fide* contracts ?—Yes.

4130. Contracts which have existed previous to  
your examination to-day ?—Yes.

4131. (*Major-Gen. Taylor.*) In accordance with the  
proposal made the other day by Capt. Noble ?—

Yes ; but as I said the present prices of guns are no  
criterion as to what they will be. The price for  
which we have a large contract for the gun which  
you have, the 70-pounder, is 700*l.*

4132. (*Col. Simmons.*) And would you let those  
prices, if you please, include the projectiles as well as  
the gun ?—Yes ; both steel and iron and shell too.

(*Col. Simmons.*) Then Sir William will do the  
same ; Capt. Noble said he would, provided Mr. Whit-  
worth did the same.

(*The Witness.*) Yes ; we will give it with very  
great pleasure.

Adjourned.



## APPENDIX.

SIR W. G. ARMSTRONG to the SECRETARY, ARMSTRONG and WHITWORTH GUN COMMITTEE.

8, Great George Street,  
January 17, 1863.

SIR,

You will receive herewith a tabulated statement,\* accompanied by drawings of the various guns, projectiles, and fuzes, which I propose to submit to the Committee as a scheme or general system of ordnance, so far as field artillery is concerned.

The first gun in this statement is the present service 6-pounder. This gun is intended for service in mountainous and difficult countries, and weighs, without its fittings, rather less than 3 cwt., or a load for a horse's back. As yet I do not trouble the Committee with a gun still lighter than this for carriage by a mule—the design for it being not yet fully matured.

The second gun on the list is the present service 9-pounder rifled gun for horse artillery.

The third is the present service 12-pounder field gun. The 9-pounder and the 12-pounder are of the same calibre, and their ammunition is therefore interchangeable.

The fourth gun is the service 20-pounder in use at present as a naval gun. I now submit it as a field gun, in place of the 24-pounder howitzer.

The fifth gun is the present service 40-pounder. This gun is about 5 cwt. lighter than the old 18-pounder smooth bore, and may take its place as a gun of position with great advantage.

All these guns are made of wrought iron, upon what is called the coil system, by which the material is applied in the form most favourable for strength, and in the manner which best ensures the detection of all dangerous flaws. They are all constructed to load at the breech.

Upon the question of breech-loading for field artillery much difference of opinion prevails. Its advantages are, first, the certainty of the projectile being driven home to its seat, whereby the danger of bursting or injuring the gun by a vacancy being left between the charge and the projectile is avoided. Secondly, exemption from the risk to the man at the muzzle by premature discharge either by sparks left in the bore or by undue haste in firing the gun. Thirdly, greater facility and rapidity of loading, and, fourthly, somewhat less exposure of the detachment serving the gun to small arm firing. Its disadvantages are inferior simplicity of construction, and the necessity of carrying tools for keeping the tightening surfaces in proper order.

As I cannot anticipate the conclusion of the Committee as to the expediency of breech-loading for field guns, I shall submit to them, in addition to the guns I have named, a muzzle-loading 12-pounder, rifled upon my shunt principle, and adapted for projectiles and fuzes similar to those for the breech-loading guns, except that the projectiles instead of being coated with lead, are provided with small brass studs projecting into the three shallow grooves with which the gun is rifled. I adhere in this projectile to the principle of using a relatively soft material for giving rotation, and of applying compression to this material to prevent the vibration of the projectile in the bore.

The projectiles to be used with these various guns are delineated in the drawings left herewith.

The most important of them is the segment shell. It is built up internally of segmental pieces so compactly run together with lead as to render the penetrating power of the shell nearly the same as that of solid shot. The external case of the shell is at the same time so thin that a very small bursting charge is required for its disruption. In fact the shell is very strong against a force operating from without, and very weak against a force operating from within.

The common shell for the 12-pounder field gun is not yet in the service, and is merely proposed by me in case the Committee should think it desirable to have one. In that case a carcass of the same pattern, but with a perforated head, would also be required. Probably six common shell and two carcasses for each gun would be thought sufficient, and I would recommend that these should be carried only in the ammunition waggons, so as to avoid complication in the limber boxes.

The bursters containing the bursting charge for segment shell consist of a cylindrical case, which is dropped unopened into the shell and can be withdrawn at pleasure.

The fuzes proposed for field artillery are of two kinds, viz., the concussion fuze and the time fuze.

The concussion fuze is used for both common and segment shell. Before it is discharged from the gun it will bear great violence without exploding, but the act of firing renders the fuze so sensitive that the least check to the flight of the projectile causes ignition. The concussion fuze for common shell is not yet in the service, but will be the same as that used for segment shell, except in being screwed externally to screw into the shell in substitution for the time fuze.

The time fuze is also used for both common and segment shell. It is ignited by a percussion arrangement so as to be independent of windage, and it possesses the advantage of admitting the adjustment to be made or altered up to the last moment of loading. At present there is a want of uniformity in the screw for the time fuze in some of the shells, and I therefore propose an alteration to obviate this inconvenience, although it will involve a discrepancy between the naval and land service patterns.

The concussion and the time fuzes can be used either separately or in combination for the segment shell of all the guns. The advantage of combination is that if the time fuze fails, the concussion fuze operates on impact.

I have already said that the segment shell will act effectively as solid shot. By a proper adjustment of the fuze it will explode at the muzzle so as to operate as canister. This form of shell is therefore convertible into the three capacities of solid shot, shrapnel shell, and common case or canister, and thus the disadvantages of having to carry varieties of projectiles which may not suit the necessity of the moment is avoided.

Both forms of fuze are now constructed in a manner which renders them proof against all ordinary exposure to damp or heated atmosphere.

The drawings supplied to the Committee furnish only such particulars of the guns as are necessary to define their pattern. To have shown the details of manufacture would have rendered them too complicated, but, if the Committee desire to have such details, I shall be glad to supply them.

I will furnish the Committee as early as possible with similar particulars and drawings of the guns and projectiles which I propose as a scheme or system of ordnance for naval and garrison service and for siege operations.

I have, &c.

W. G. ARMSTRONG.

SIR W. G. ARMSTRONG to the SECRETARY, SPECIAL ARMSTRONG and WHITWORTH COMMITTEE, 109, Victoria Street.

8, Great George Street, Westminster,  
January 21st, 1863.

SIR,

REFERRING to the last paragraph of your letter of the 19th instant, Min. 7/1, in which you state that drawings and specifications of every description of ammunition I propose to use are required to enable the manufacture to be commenced at the Royal Laboratory, Woolwich, I beg leave to observe that I particularly wish, and in fact deem it necessary, that the whole of the projectiles, fuzes, and bursters to be used with my guns in the approaching trials should be made under my own direction at the Elswick Ordnance Works and not in the Royal Laboratory, where I have no control.

I have, &c.

W. G. ARMSTRONG.

SIR W. G. ARMSTRONG to the SECRETARY, SPECIAL ARMSTRONG and WHITWORTH COMMITTEE.

8, Great George Street, Westminster,  
January 26th, 1863.

SIR,

I HAVE the honour to send herewith a tabulated statement\* of the various guns, projectiles, and fuzes which I propose as a general scheme or system of rifled artillery for siege, garrison, and naval use. The statement is drawn up in the same manner as the former one having reference to field artillery, and it contains similar particulars of the guns and ammunition. It is also accompanied by drawings which show the various patterns.

\* Tabulated statement, page 160, Appendix.

\* Tabulated statement, page 160, Appendix.



The first three guns on this list are the 6-pounder, 12-pounder, and 20-pounder, which I propose as boat-guns and for field service by naval forces on shore. The 20-pounder may also be used as a broadside gun for small ships.

The next two guns are both 40-pounders and use the same ammunition. They are designed for siege, garrison, and naval purposes, and differ only in one being shorter than the other, and fitted with the wedge breech-loading arrangement to render it more suitable for narrow waisted ships.

The two guns next on the list are at present called 70-pounders. One of them is a breech-loader and the other a muzzle-loader. I suggest that, for reasons to be presently given, these and all heavier guns be denominated according to the weight of the piece rather than that of the projectile; and that accordingly these guns be called respectively the 3-ton breech-loading gun and the 3-ton muzzle-loading gun. The breech-loader is fitted with the wedge arrangement. The muzzle-loader, which, like all my muzzle-loaders, is rifled on the shunt system, is not in the service, and is submitted for adoption in case it be deemed desirable to have a muzzle-loading gun of this weight and calibre. Both guns are designed for siege, garrison, and naval use.

The succeeding gun is the present 110-pounder or 4-ton gun. I offer it to the Committee in its existing form, but I propose that guns of this nature shall for the future be constructed with the wedge instead of the screw arrangement, an alteration of pattern which will not affect the ammunition. The 4-ton gun is also intended for siege, garrison, and naval use.

The 7-inch howitzer carries the same projectile as the preceding gun but with a smaller charge. It weighs under three tons, and has proved itself remarkably effective against masonry and earthworks. Its portability and efficiency render it especially valuable for siege purposes.

The remainder of the guns specified in the statement have not yet passed into the service, but are mostly ready for trial.

The 6½ ton gun is a muzzle-loader designed expressly as a broadside gun for the largest ships now afloat.

The 8-ton gun is a breech-loader on the wedge plan.

The 12-ton gun is a muzzle-loader.

Both these guns are suitable for shield ships and other vessels carrying large pivot or turntable guns. They are also peculiarly adapted for shore batteries as a protection against iron-plated ships.

The 23-ton gun is a muzzle-loader, and can only be regarded as a fort gun, although I anticipate the time when ships will be constructed capable of carrying guns of this magnitude.

The 7-inch mortar is the only specimen of a rifled mortar which I have yet had an opportunity of constructing. It was made as an experiment, and although it has given satisfactory results I consider that it is capable of great improvement. Its lightness and the great power of its shell would render it an important auxiliary in siege operations.

It will be observed that in these various guns two methods of rifling are employed. The principle, however, involved in each method is the same, viz., that of using a soft metal for giving rotation and steadiness in the bore. In the smaller projectiles there appears to be no objection to a complete coating of soft metal; but in projectiles of the largest class, designed more especially for use against armour plates, it is desirable to reduce the quantity of the soft material to a minimum. For this reason I prefer the brass studded projectile for the largest ordnance, especially as it has the advantage of being applicable both to breech-loaders and muzzle-loaders.

On the subject of breech-loading as applied to heavy ordnance, I would observe that for naval and casemate guns breech-loading offers great advantages. It obviates the necessity of running back the gun to gain access to the muzzle, and thereby enables larger guns to be used in a limited space than would otherwise be practicable. It also enables the gun to be worked with less exposure of the men to small arm firing. On the other hand breech-loading involves additional weight, so that weight for weight a breech-loader is less powerful than a muzzle-loader. Up to the introduction of armour plating there was no difficulty in getting the requisite power in a gun without exceeding a convenient weight; but now that it has become necessary greatly to increase the power of the gun, the weight of it has become a more important element. Another reason for not as yet applying breech-loading to the heaviest guns is that we are at present without sufficient experience as to the practicability of so doing. These circumstances explain why I put forward for the consideration of the Committee specimens of heavy guns, both of the breech-loading and muzzle-loading class.

Another question may be raised as to the *mode* of breech-loading for heavy ordnance. It has been urged against the present method that the weight of the vent piece in large guns makes it inconvenient to lift. I have always been sensible of this objection, and I have from the first endeavoured to meet it by arranging the closing apparatus to move by a sliding instead of a lifting action. I have now matured an arrangement of this nature in which there is no escape of gas and no probability of firing the gun while the breech is imperfectly closed. This system of breech-loading I propose to apply to all future guns above the 40-pounder calibre. The Committee will have an example of it on a large scale in the 8-ton gun.

In fixing the diameter of bore for my guns I have been led by the following considerations to lean rather to large than to small bores. With a given length of gun and a given charge a larger bore, by affording more room for the expansion of the gas, gives a higher initial velocity. The projectile also is by increase of bore rendered more destructive, because, as a shot, it makes a larger hole, and as a shell, it produces a greater explosive effect. On the other hand the projectile of the smaller bore has more penetration and suffers less retardation from the atmosphere; but as the ultimate object is destructive effect I consider that the bore should be as large as is compatible with sufficient penetration for the lodgement of shells. Several guns of six tons weight and seven inches calibre are now being manufactured on my system of construction in the Royal Gun Factory, with a view to experiments by the Ordnance Select Committee on different methods of rifling. I have requested that one of these may be rifled on my shunt system in order that it may be handed over to your Committee as a specimen of a small bore gun for the attainment of greater penetration to meet the possible demands of future exigencies.

The projectiles for the various guns up to and inclusive of those for the 4-ton gun are intended to meet all the requirements of general service, excepting only iron defences, which necessitate heavier guns and special projectiles of a more costly nature. They are of cast iron, and comprise solid shot, and common and segment shell, all of the same character as those used for field artillery.

The projectiles for the heavier guns are designed partly for general service and partly for the special purpose of operating against armour plates. For the latter purpose they are mostly made of steel, and comprise solid shot, and common and segment shell. For all these projectiles I prefer the rounded form of head. The steel shells are peculiar in being open at the front so as to throw their explosive effect in a forward direction. The opening is closed with a cast-iron nozzle, which gives the shell an improved form for flight and furnishes the means of exploding it on impact. The same pattern of shell is applicable for use with molten iron.

The best weight for the solid shot of heavy guns is still a matter of doubt. Recent experiments appear to show that in the case of the 4-ton gun it will be advantageous to reduce the weight of the solid shot to about 70 lbs., but as this question is still under investigation, I have no alternative but to submit to your Committee both a light and heavy shot for this gun. Probably before the Committee arrive at this stage of their inquiry I shall be able to state definitely which I prefer. Under any circumstances it would be undesirable to reduce the weight of the shells, as that could be done only at a sacrifice of explosive effect.

The fuzes for the smaller natures of the guns comprised in this statement up to and including the 20-pounder are the same as those proposed for field service. For the shells of the larger natures I have found it necessary to adopt a different form of percussion fuze, viz., the pillar fuze. The reason of this necessity is that in naval warfare a large proportion of the shells graze the water before striking their object, and it is necessary to prevent their ignition by the shock of striking water. Such a retardation of the fuze would be inconsistent with effective use in the field, and hence the necessity for adopting a different pattern for the naval percussion fuze. I propose, however, to retain the "percussion fuze" of the field service pattern to be used in cases where greater sensibility is required.

I have made the external screw of the sea service fuzes the same as that of the percussion fuze for spherical shells, it having been deemed necessary to make them interchangeable; I should prefer to assimilate the screws of the present land service and sea service fuzes, but this could not now be done without great sacrifice of material.

I have, &c.  
W. G. ARMSTRONG.



JOSEPH WHITWORTH, Esq., to the Right Honourable  
EARL DE GREY AND RIFON, War Office, Pall Mall.

28, Pall Mall,  
December 25, 1862.

MY LORD,

I HAVE read over the programme of the trials proposed to be made by my guns in comparison with those of Sir W. Armstrong. By the latter I take for granted, the rifled breech-loading guns which have been adopted for the service are meant.

The programme appears to embrace the points of comparison that are necessary, and I have no suggestion to make upon them.

In comparing the two systems together, the distinctive features of each should be borne in mind, and I think they will be easily understood when placed side by side.

1st. The guns which I propose are muzzle-loaders (like those supplied in 1858); they may however be used as breech-loaders, and also as both if required, but I have myself always advocated muzzle-loaders on account of their greater simplicity.

2nd. They are rifled hexagonally, with a rapid turn, which enables long projectiles of great capacity to be employed.

3rd. My projectiles are made entirely of hard metal rifled by self-acting machinery, the windage allowed being sufficient to give easy loading and provide for the ignition of the simple time fuze by the flame of the explosion.

4th. My field guns are constructed solid throughout of homogeneous metal. For the heavy guns made by me for ships and fortifications I employ an inner tube, closed by a screw breech, and strengthened by hoops which are pressed on cold by hydraulic pressure.

5th. Both inner tubes and hoops are made without welding of homogeneous metal.

After the comparison has been made between the gun adopted for the service and that which I proposed, if it be thought advisable to make further comparisons I shall be quite ready for my guns to be compared with any that may be brought forward.

I am, &c.

(Signed) JOSEPH WHITWORTH.

JOSEPH WHITWORTH, Esq., to CAPTAIN H. DYER,  
Secretary, WHITWORTH and ARMSTRONG GUN  
COMMITTEE.

SIR,

Manchester, January 24, 1863.

IN reply to your letter of the 19th instant in which you ask whether the tabular statement furnished to the

Committee by me, contains the details of every nature and description of ordnance and ammunition proposed to be submitted by me, I beg to say that the table contains a list of the rifled guns and projectiles which are now being manufactured by my firm, and I submit it for selection.

They are all of one nature or principle, as are indeed all my rifled guns, from the smallest bore rifle to the largest cannon or mortar, and I have no other system to propose. I would submit that it is for the War Department and the Admiralty to determine what are the requirements of the two services.

If I am informed for what purpose a particular gun is required, and the weight and length that is admissible be given, I should then be able to make the guns to meet those requirements; or if the object were stated, for instance to effect penetration at a given range through a given thickness of material, I could say what gun and projectile I would undertake to make to effect the object.

I would suggest to the Committee that as the 12-pounder Armstrong is the size of field gun in the service, that it should compete with my 12-pounder gun.

That for a naval gun the 70-pounder Armstrong should be put into competition with my 70-pounder, which is a medium size, and could be supplied soon.

I presume the Committee would require three of each in order to obtain an average of results in the trials for endurance.

The shot and shell required by the Committee for these experiments I should wish to be supplied by my firm, who have now every facility for their economical production, as will be seen by reference to the tabular statement.

The shells could be forwarded to the Royal Laboratory to be filled and to have the fuzes applied.

I am, &c.

JOSEPH WHITWORTH.

THE O. S. COMMITTEE to the SECRETARY, SPECIAL  
COMMITTEE, WHITWORTH and ARMSTRONG GUNS.

SIR,

January 19, 1863.

IN reference to your request of the 12th instant Min. 4/2 for information respecting the observed penetrations of Armstrong and Whitworth projectiles, I beg to enclose a memorandum of all the observations I am acquainted with.

It will have been observed by the Special Committee that a very full comparison of the guns in this respect formed part of the Ordnance Select Committee's programme of April 1860, Min. 1001; but the Committee have never been in a position to carry that programme out.

With respect to the Armstrong guns, great difficulty has been experienced in finding earthwork of a suitable character, in a situation where live shells could be safely used, and under conditions which would allow of the shot or blind shells being dug out at the time. A mound of earth was erected last year at Shoeburyness which is to be fired into when sufficiently consolidated, and there are experiments to be made in the spring on a natural bank near Newhaven.

These will furnish more extensive data than the Ordnance Select Committee can as yet supply.

I have, &c.

H. HEYMAN, Captain R.A.,  
Assistant Secretary, O. S. C.

## PENETRATION INTO BRICK.

## ARMSTRONG GUNS.

19/1/63.

| Date.      | Gun.                                                                                                                                                       |                | Charge. | Weight of Projectile. | Distance. | Penetration. | Remarks.                                   |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|---------|-----------------------|-----------|--------------|--------------------------------------------|
|            |                                                                                                                                                            |                | lbs.    | lbs.                  | yards.    | ft. in.      |                                            |
| Sept. 1860 | Exceptional 80-pounder, or 6-inch.                                                                                                                         | Shot - -       | 10      | 82                    | 1,032     | 8 6          | Mean of 2 at Bexhill.                      |
|            | " - -                                                                                                                                                      | Common shell - | 9       | 77                    | —         | 4 3          |                                            |
|            | 40-pounder                                                                                                                                                 | Shot - -       | 5       | 41                    | —         | 4 1½         | Mean of 2 at Bexhill.                      |
| 1859       | 32-pounder exceptional, stated in 2nd report of a special committee, dated 7th April 1859, to be 4 or 5 feet. Distance not stated, but probably 600 yards. |                |         |                       |           |              |                                            |
| 1861       | 12-pounder - -                                                                                                                                             | Segment - -    | 1½      | 12                    | 71        | 2 0          | Mean of 15, Bexhill. Brickwork very solid. |
|            | 12-pounder - -                                                                                                                                             | Segment - -    | 1½      | 12                    | 71        | 2 8½         |                                            |
|            | " - -                                                                                                                                                      | Shot - -       | —       | —                     | 71        | 2 9          |                                            |
|            | " - -                                                                                                                                                      | Segment - -    | 2       | 12                    | 71        | 3 2          |                                            |

## WHITWORTH GUNS.

No observations made by Ordnance Select Committee.

## PENETRATION INTO EARTH.

## ARMSTRONG GUNS.

|      |            |          |   |    |     |      |                                                 |
|------|------------|----------|---|----|-----|------|-------------------------------------------------|
| 1859 | 32-pounder | Shot - - | — | 32 | 600 | 12 6 | See above-quoted report of a special committee. |
|------|------------|----------|---|----|-----|------|-------------------------------------------------|

## WHITWORTH GUNS.

No observation made by Ordnance Select Committee.

## PENETRATIONS INTO OAK.

|      |            |               |    |    |       |        |                                                   |
|------|------------|---------------|----|----|-------|--------|---------------------------------------------------|
| 1858 | 18-pounder | Shot - -      | 3  | 18 | 400   | 6 0    | Passed through and went 601 yards down the range. |
| 1861 | 12-pounder | Shot - -      | 1½ | 12 | 400   | 3 4.0  |                                                   |
|      |            | —             | 1¾ | —  | —     | 3 1.3  |                                                   |
|      |            | —             | 2  | —  | —     | 3 5.6  |                                                   |
|      |            | —             | 1½ | 12 | 1,200 | 2 11.0 |                                                   |
|      |            | —             | 1¾ | —  | —     | 3 8.0  |                                                   |
| 1861 | 12-pounder | Segment shell | 1½ | 12 | 400   | 2 2.7  | Mean of 4.                                        |
|      |            | —             | 1¾ | —  | —     | 1 11.7 |                                                   |
|      |            | —             | 2  | —  | —     | 2 0.3  |                                                   |
|      |            | —             | 1½ | 12 | 1,200 | 1 1.5  |                                                   |
|      |            | —             | 1¾ | —  | —     | 1 4.1  |                                                   |

## WHITWORTH SHOT INTO OAK.

|      |            |          |    |    |     |       |            |
|------|------------|----------|----|----|-----|-------|------------|
| 1861 | 12-pounder | Shot - - | 1½ | 12 | 400 | 4 1   | Mean of 3. |
|      |            | Shot - - | 1¾ | 12 | 400 | 4 6.5 | Mean of 4. |



TABULAR STATEMENT of all the different Descriptions of ORDNANCE and AMMUNITION proposed by SIR W. ARMSTRONG for SIEGE, GARRISON, and NAVAL SERVICE.

| Nature of Ordnance. | Length.      |            |                          |            | Pitch of Rifling. |            | Muzzle or Loader. | Charge. | Projectile.      |                      | Material of Gun. | Cost.      |    |                  |          |          |                |                  |                   |              |               |                 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|                     | Of Bore.     |            | Of Gun without Fittings. |            | Inches.           |            |                   |         | Weight complete. | Nature and Material. |                  | Length.    |    | Bursting Charge. | Windage. | Of Gun.  | Of Solid Shot. | Of Common Shell. | Of Segment Shell. | Of Burstier. | Of Time Fuze. | Of Common Fuze. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                     | In Calibres. | In Inches. | In Calibres.             | In Inches. | In Calibres.      | In Inches. |                   |         |                  |                      |                  |            |    |                  |          |          |                |                  |                   |              |               |                 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                     |              |            |                          |            |                   |            |                   |         |                  |                      |                  |            |    |                  |          |          |                |                  |                   |              |               |                 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 pounder           | cwt.         | 2.5        | 21.2                     | 53.        | 24.05             | 60.125     | 30.               | 75.     | B.               | 0.75                 | 6 5              | Seg. shell | 2. | 5.0              | lbs. oz. | 179 grs. |                |                  |                   |              |               |                 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

The 6½ ton, the 8 ton, the 12 ton, and the 23 ton guns and their projectiles are at present experimental, and their cost cannot yet be stated. In addition to the cast-iron projectiles specified for these guns, steel projectiles will be provided. These steel projectiles will consist of solid shot, common shell, segment shell, and shells for molten iron. Drawings of the steel projectiles for the 12-ton gun are sent herewith, and may be regarded as types for those of the other guns.

\* No contract prices, but these figures may be considered closely approximate.

26th January 1863.

W. G. ARMSTRONG.

TABULAR STATEMENT of all the different Descriptions of ORDNANCE and AMMUNITION proposed by Sir WILLIAM ARMSTRONG for Field Artillery.  
(Lubricating wads are used with these projectiles.)

| Nature of Ordnance. | Weight.  | Length.     |            |                          |            | Pitch of Rifling.   |                | Muzzle or Breech-Loader. | Charge. | Projectile.      |                  |                   |           | Windage.   | Material of Gun. | Cost.*        |                     |            |           |           |           |
|---------------------|----------|-------------|------------|--------------------------|------------|---------------------|----------------|--------------------------|---------|------------------|------------------|-------------------|-----------|------------|------------------|---------------|---------------------|------------|-----------|-----------|-----------|
|                     |          | Of Bore.    |            | Of Gun without Fittings. |            | Nature of Material. | Length.        |                          |         | Bursting Charge. |                  |                   |           |            |                  |               |                     |            |           |           |           |
|                     |          | In Calibre. | In Inches. | In Calibre.              | In Inches. |                     |                |                          |         |                  |                  |                   |           |            |                  |               |                     |            |           |           |           |
|                     |          |             |            |                          |            |                     | Of Solid Shot. |                          |         |                  | Of Common Shell. | Of Segment Shell. | Of Burst. |            |                  | Of Time Fuse. | Of Concussion Fuse. |            |           |           |           |
| 6-pounder -         | cwt. 3.3 | 21.2        | 5.3        | 24.05                    | 60.125     | 30                  | 75             | Breech                   | 0.75    | lbs. oz. 6 5     | Seg. shell -     | 2                 | 5         | 179 grains | †                | s. d. —       | s. d. —             | s. d. 2 1½ | s. d. 0 5 | s. d. 2 0 | s. d. 1 0 |
| 9-pounder -         | 6.0      | 17.5        | 52.5       | 20.66                    | 62         | 38                  | 114            | Breech                   | 1.25    | 9 5              | Seg. shell -     | 1.783             | 5.35      | 365 grains | †                | —             | —                   | 2 5        | 0 6       | 2 0       | 1 0       |
| 12-pounder -        | 8.5      | 3.00        | 73.5       | 28.041                   | 84.125     | 38                  | 114            | Breech                   | 1.5     | 11 10            | Seg. shell -     | 2.25              | 6.75      | 520 grains | 90               | —             | —                   | 2 8½       | 0 7       | 2 0       | 1 0       |
| 20-pounder -        | 12.5     | 3.75        | 14.43      | 54.125                   | 66.125     | 38                  | 142.5          | Breech                   | 2.625   | 20 9             | Solid shot -     | 2.18              | 8.195     | 10 oz.     | —                | —             | 2 8                 | —          | —         | —         | 1 1       |
| 40-pounder -        | 33       | 4.75        | 106.375    | 25.4                     | 121        | 36.5                | 173.5          | Breech                   | 5       | 21 12            | Com. shell -     | 3                 | 11.25     | 1 lb.      | 130              | 3 8           | —                   | 4 3        | 0 8       | 2 0       | 1 1       |
| 12-pounder -        | 8.3      | 3.00        | 22.6       | 67.74                    | 25.1       | 75.24               | 35             | 105                      | Muzzle  | 1.5              | 41 3             | Solid shot -      | 2.13      | 10.16      | 249              | 6 5           | —                   | —          | —         | —         | —         |
|                     |          |             |            |                          |            |                     |                |                          |         |                  | 40 8             | Seg. shell -      | 2.22      | 10.585     | —                | —             | —                   | 8 2        | —         | 2 0       | 1 1       |
|                     |          |             |            |                          |            |                     |                |                          |         |                  | 41 7             | Com. shell -      | 2.91      | 13.875     | —                | —             | —                   | —          | —         | —         | 1 1       |
|                     |          |             |            |                          |            |                     |                |                          |         |                  | 11 10            | Seg. shell -      | 2.4       | 7.175      | 90§              | —             | —                   | 2 1§       | 0 7       | 2 0       | 1 0       |
|                     |          |             |            |                          |            |                     |                |                          |         |                  |                  |                   |           | 520 grains |                  |               |                     |            |           |           |           |
|                     |          |             |            |                          |            |                     |                |                          |         |                  |                  |                   |           | 0.04 ins.  |                  |               |                     |            |           |           |           |

\* There is room for much ambiguity on the question of cost. If the articles be made in the Government establishments, and exempted wholly or partially from various charges of a general nature which a contractor must necessarily make, the estimated cost would appear considerably less. For any purpose of comparison it will be necessary to keep this distinction in view.

† There are no guns of this pattern now being made under contract, and the price can therefore only be estimated. The price of the 6-pounder would be about 60l., and that of the 9-pounder about 80l.

‡ Solid shot are made for these guns, but only for purposes of practice.

§ Estimated prices.

17th January 1863.

W. G. ARMSTRONG.



TABLE 3. STATEMENT of the different SIZES of RIFLED GUNS and PROJECTILES now manufactured by MR. WHITWORTH'S Firm and submitted by him for the COMMITTEE'S Selection.

(Any other sizes of guns the Committee may desire would be made on the same principle.)

| Nature of Ordnance.  | Weight. | Length.                |            |                  |            | Pitch of Rifling. |            | Muzzle or Breech Loader. | Projectile. |                                                                                                                                                                                                                                                                                                        | Material of Gun.      | Price.       |            |                   |          |         |                     |         |           |
|----------------------|---------|------------------------|------------|------------------|------------|-------------------|------------|--------------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------|------------|-------------------|----------|---------|---------------------|---------|-----------|
|                      |         | Of Bore.               |            | Of Gun over all. |            | In Calibres.      | In Inches. |                          | Weight.     | Nature and Material.                                                                                                                                                                                                                                                                                   |                       | In Calibres. | In Inches. | Charge of Powder. | Windage. | Of Gun. | Of solid Shot each. | Common. | Shrapnel. |
|                      |         | In Calibres.           | In Inches. | In Calibres.     | In Inches. |                   |            |                          |             |                                                                                                                                                                                                                                                                                                        |                       |              |            |                   |          |         |                     |         |           |
|                      |         |                        |            |                  |            |                   |            |                          |             |                                                                                                                                                                                                                                                                                                        |                       |              |            |                   |          |         |                     |         |           |
|                      |         | cwt. qrs. lbs. inches. |            |                  |            |                   |            |                          |             |                                                                                                                                                                                                                                                                                                        |                       | £            | s. d.      | s. d.             | s. d.    |         |                     |         |           |
| 1-pounder rifled gun | -       | 0 3 16                 | 1.31       | 32               | 42         | 45                | 20         | Muzzle                   | 1           | The solid shot, common and shrapnel shells, are of cast iron, with conical front and taper rear. Shells for penetrating metal plates and for passing through water have flat fronts and are made of iron and steel. The cross section of all the projectiles is hexagonal, with the angles turned off. | Brass or homogeneous. | 35           | 0 1½       | 0 1½              |          |         |                     |         |           |
| 3-pounder            | -       | 2 2 5                  | 1.88       | 28               | 52         | 55                | 30         | "                        | 3           |                                                                                                                                                                                                                                                                                                        | "                     | 60           | 0 4½       | 0 4½              |          |         |                     |         |           |
| 6-pounder            | -       | 4 3 8                  | 2.38       | 26               | 61         | 65                | 40         | "                        | 6           |                                                                                                                                                                                                                                                                                                        | "                     | 75           | 0 9        | 0 9               | 0 10½    |         |                     |         |           |
| 9-pounder            | -       | 7 1 0                  | 2.72       | 26               | 70         | 75                | 50         | "                        | 9           |                                                                                                                                                                                                                                                                                                        | "                     | 100          | 1 1½       | 1 1½              | 1 4      |         |                     |         |           |
| 12-pounder           | -       | 9 2 16                 | 3.         | 26               | 79         | 85                | 55         | "                        | 12          |                                                                                                                                                                                                                                                                                                        | "                     | 120          | 1 6        | 1 6               | 1 9      |         |                     |         |           |
| 4-inch               | -       | 32 2 20                | 4.14       | 21               | 87         | 95                | 75         | "                        | 32          |                                                                                                                                                                                                                                                                                                        | "                     | 400          | 4 0        | 4 0               | 4 8      |         |                     |         |           |
| 5½-inch              | -       | 75 0 0                 | 5.5        | 20               | 110        | 120               | 100        | "                        | 70          |                                                                                                                                                                                                                                                                                                        | "                     | 700          | 8 9        | 8 9               | 10 2     |         |                     |         |           |
| 7-inch               | -       | 145 0 0                | 7.0        | 18               | 126        | 140               | 130        | "                        | 150         |                                                                                                                                                                                                                                                                                                        | "                     | 1,350        | 18 9       | 18 9              |          |         |                     |         |           |
| 9-inch               | -       | 290 0 0                | 9.0        | 15               | 135        | 150               | 160        | "                        | 325         |                                                                                                                                                                                                                                                                                                        | "                     | 2,800        | 40 0       | 40 0              |          |         |                     |         |           |

Whether Sponge or Lubrication of any Description is required?—Lubricating wad of wax and tallow and dry sponge are desirable.

JOSEPH WHITWORTH.

24th January 1863.

## FACING IMPLEMENTS for 6-Pr. ARMSTRONG GUNS.

In a Box, with Hinges and Hasps, and Padlock with two Keys.

|                                                    | Letter. | No. of each. |
|----------------------------------------------------|---------|--------------|
| Blocks { breech bush, { angle facing - - - - - L 1 |         |              |
| { copper { finish boring - - - - - K 1             |         |              |
| { screwing in - - - - - H 1                        |         |              |
| { upsetting - - - - - I 1                          |         |              |
| Guard, wood, for vent-piece - - - - - N 1          |         |              |
| Guides { in breech screw - - - - - Q 1             |         |              |
| { in powder chamber - - - - - D 2                  |         |              |
| Key, for fixing knives - - - - - E 1               |         |              |
| Knives { breech bush, { cutting out - - - - - O 1  |         |              |
| copper { facing - - - - - F 1                      | M & M 1 | 2            |
| { rough boring - - - - - J 1                       |         |              |
| Lever - - - - - B 1                                |         |              |
| Punch, for pin in spindle - - - - - R 1            |         |              |
| Spanner, for stop-washers - - - - - P 1            |         |              |
| Spindle - - - - - A 1                              |         |              |
| Washers, stop - - - - - C 2                        |         |              |

## FACING IMPLEMENTS for 20-Pr. ARMSTRONG GUNS.

In a Box, with Hinges and Hasps, and Padlock with two Keys.

|                             | Letter.                           | No. of each. |  |
|-----------------------------|-----------------------------------|--------------|--|
| Blocks {                    | angle facing                      | K 1          |  |
|                             | finish { 3·875 diameter           | I 1 1        |  |
|                             | boring { 3·94 diameter            | I 2 1        |  |
|                             | screwing in                       | G 1          |  |
|                             | copper { upsetting                | M 1          |  |
|                             | vent-piece ring, angle facing     | L 1          |  |
| Guard, wood, for vent-piece | P 1                               | 1            |  |
| Guides {                    | in breech screw                   | C 2          |  |
|                             | in powder { 3·875 diameter        | D 1 1        |  |
|                             | chamber { 3·94 diameter           | D 2 1        |  |
|                             | wood (block upsetting), two parts | Q 1          |  |
| Knives {                    | breech bush, { cutting out        | F 1          |  |
|                             | copper { facing                   | J & J 1 2    |  |
|                             | rough boring                      | H 1          |  |
| Key, for fixing knives      | N 1                               |              |  |
| Lever                       | B 1                               |              |  |
| Punch, for pin in spindle   | R 1                               |              |  |
| Spanner, for stop-washers   | O 1                               |              |  |
| Spindle                     | A 1                               |              |  |
| Washers, stop               | E 2                               |              |  |

## FACING IMPLEMENTS for 12 and 9-Pr. ARMSTRONG GUNS.

In a Box, with Hinges and Hasps, and Padlock with two Keys.

|                                             | Letter.                              | No. of each. |
|---------------------------------------------|--------------------------------------|--------------|
| Blocks {                                    | angle facing - - - - -               | I 1          |
|                                             | finish { 3·125 diameter - - - - -    | F 1 1        |
|                                             | boring { 3·2 diameter - - - - -      | F 2 1        |
|                                             | screwing in - - - - -                | D 1          |
|                                             | upsetting - - - - -                  | C 1          |
| vent-piece ring, angle facing - - - - -     | J 1                                  |              |
| Guard, wood, for vent-piece - - - - -       | S 1                                  |              |
| Guides {                                    | in breech screw - - - - -            | M 2          |
|                                             | in powder { 3·125 diameter - - - - - | N 1 1        |
|                                             | chamber { 3·2 diameter - - - - -     | N 2 1        |
| wood (block upsetting), two parts - - - - - | R 1                                  |              |
| Key, for fixing knives - - - - -            | O 1                                  |              |
| Knives {                                    | breech bush, { cutting out - - - - - | K 1          |
|                                             | copper { facing - - - - -            | G & G 1 2    |
|                                             | rough boring - - - - -               | E 1          |
| Lever - - - - -                             | B 1                                  |              |
| Punch, for pin in spindle - - - - -         | P 1                                  |              |
| Spanner, for stop-washers - - - - -         | Q 1                                  |              |
| Spindle - - - - -                           | A 1                                  |              |
| Washers, stop - - - - -                     | L 2                                  |              |

## FACING IMPLEMENTS for 110-Pr. ARMSTRONG GUNS.

In a Box, with Tray, Hinges, and Hasps, and Padlock with two Keys.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Letter.                                                                         | No. of each.                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------|
| Blocks { breech bush, iron { cutting out, boring, facing, tapering, and angle facing - - - - - screwing in, and rough boring - - - - - vent-piece, angle facing - - - - - wrench, for trunnion sights (used with special tools) - - - - - Guard, wood, for vent-piece - - - - - Guides { in breech screw - - - - - in powder chamber - - - - - Handle, to hold blocks in vent-chamber - - - - - Knives, cutting out breech bush { thick iron - - - - - thin iron - - - - - Lever - - - - - Punch, for pin in spindle - - - - - Spanner, for stop-washer - - - - - Spindle - - - - - Washers, stop - - - - - | G<br>F 1<br>K<br>Q<br>O<br>C<br>D 1<br>P<br>E 2<br>E 1<br>B<br>N<br>M<br>A<br>J | 1<br>1<br>1<br>1<br>1<br>2<br>1<br>1<br>2<br>1<br>1<br>1<br>1<br>2 |

## FACING IMPLEMENTS (O.P.) for 40-Pr. ARMSTRONG GUNS.

In a Box, with Hinges and Hasps, and Padlock with two Keys.

|                                        |                                       | Letter.                                   | No. of each. |
|----------------------------------------|---------------------------------------|-------------------------------------------|--------------|
| Blocks                                 | { breech bush, copper                 | { angle facing - - -                      | G 1          |
|                                        |                                       | { cutting out - - -                       | D 1          |
|                                        |                                       | { finish { 4·91 diameter - - -            | F 1 1        |
|                                        |                                       | { boring { 4·96 diameter - - -            | F 2 1        |
|                                        |                                       | { screwing in - - -                       | E 1          |
|                                        |                                       | { upsetting - - -                         | M 1          |
| Collar, for feed motion                | { vent-piece ring, angle facing - - - | H 1                                       |              |
|                                        | { for feed motion - - -               | B 1                                       |              |
| Guides                                 | { in breech screw - - -               | A 1                                       | 1            |
|                                        |                                       | { in powder { 4·91 diameter - - -         | C 1 1        |
|                                        |                                       | { chamber { 4·96 diameter - - -           | C 2 1        |
|                                        |                                       | { wood (block upsetting), two parts - - - | N 1          |
| Handle, to hold blocks in vent-chamber |                                       | P                                         | 1            |
| Lever                                  |                                       | J                                         | 1            |
| Punch                                  | { for knives in blocks - - -          | K 1                                       | 1            |
|                                        |                                       | { for pin in spindle - - -                | L 1          |
| Spindle                                |                                       | I                                         | 1            |

## FACING IMPLEMENTS (N.P.) for 40-Pr. ARMSTRONG GUNS.

In a Box, with Hinges and Hasps, and Padlock with two Keys.

|                                        | Letter.                           | No. of each. |   |
|----------------------------------------|-----------------------------------|--------------|---|
| Blocks {                               | angle facing                      | G            | 1 |
|                                        | cutting out                       | D            | 1 |
|                                        | finish { 4·91 diameter            | F 1          | 1 |
|                                        | boring { 4·96 diameter            | F 2          | 1 |
|                                        | screwing in                       | E            | 1 |
|                                        | upsetting                         | M            | 1 |
|                                        | vent-piece ring, angle facing     | H            | 1 |
| Collar, for feed motion                | B                                 | 1            |   |
| Feed washer                            | O                                 | 1            |   |
| Guides {                               | in breech screw                   | A            | 1 |
|                                        | in powder chamber                 | C            | 1 |
|                                        | wood (block upsetting), two parts | N            | 1 |
| Handle, to hold blocks in vent-chamber | P                                 | 1            |   |
| Lever                                  | J                                 | 1            |   |
| Punch {                                | for knives in blocks              | K            | 1 |
|                                        | for pin in spindle                | L            | 1 |
| Spanner, for stop-washer               | R                                 | 1            |   |
| Spindle                                | I                                 | 1            |   |
| Stop-washer                            | Q                                 | 1            |   |





LIST of SPECIAL TOOLS for repair of Armstrong Guns, Sea Service.

|                                                       |   |   |   |   |   |   |                                  |   |   |   |   |   |   |
|-------------------------------------------------------|---|---|---|---|---|---|----------------------------------|---|---|---|---|---|---|
| Can, oil, lubricating                                 | - | - | - | - | - | 1 | Punches, brass, 7-inch           | - | - | - | - | - | 1 |
| Chiseis, cross-cut, 18-inch                           | - | - | - | - | - | 2 | " " 6 "                          | - | - | - | - | - | 1 |
| Cloth, emery, flour, sheets                           | - | - | - | - | - | 6 | " copper (5½-inch × ⅝")          | - | - | - | - | - | 1 |
| Drifts, steel, upsetting vent-bouches, 40 and 110-pr. | - | - | - | - | - | 1 | " steel - 4-inch                 | - | - | - | - | - | 1 |
| " " " " " " 20 "                                      | - | - | - | - | - | 1 | " " 6 "                          | - | - | - | - | - | 1 |
| " " " " " " 12, 9, & 6-pr.                            | - | - | - | - | - | 1 | " " 7 "                          | - | - | - | - | - | 1 |
| Files, bastard, knife, 6-inch                         | - | - | - | - | - | 4 | " " 13 "                         | - | - | - | - | - | 1 |
| " smooth " 6 "                                        | - | - | - | - | - | 3 | Screwdriver, bent                | - | - | - | - | - | 1 |
| " square, 2nd cut, safe edge, 8-inch                  | - | - | - | - | - | 1 | Spanners, 9-inch                 | - | - | - | - | - | 1 |
| " " 2nd " 6 "                                         | - | - | - | - | - | 1 | " double-ended for sights        | - | - | - | - | - | 1 |
| Handles, file, medium                                 | - | - | - | - | - | 1 | Tommies, forked                  | - | - | - | - | - | 1 |
| " " small                                             | - | - | - | - | - | 3 | " plain                          | - | - | - | - | - | 1 |
| Wrench, with pins for elevating patches               | - | - | - | - | - | 1 | Box for special tools, with lock | - | - | - | - | - | 1 |

WEIGHT, SIZE of BOXES, and PRICE of FACING IMPLEMENTS and SPECIAL TOOLS for ARMSTRONG BREECH-LOADING GUNS.

| NATURE OF GUN. | FACING IMPLEMENTS. |  |                        |          |        |                    | SPECIAL TOOLS (including Screwing Apparatus) in Two Boxes. |  |                          |            |         |                      |
|----------------|--------------------|--|------------------------|----------|--------|--------------------|------------------------------------------------------------|--|--------------------------|------------|---------|----------------------|
|                | Weight with Box.   |  | Size of Box in Inches. |          |        | Price without Box. | Weight with Boxes.                                         |  | Size of Boxes in Inches. |            |         | Price without Boxes. |
|                | Cwt. qrs. lbs.     |  | Length.                | Breadth. | Depth. | £ s. d.            | Cwt. qrs. lbs.                                             |  | Length.                  | Breadth.   | Depth.  | £ s. d.              |
| 110-pr. - -    | 3 1 4              |  | 62½                    | 15       | 11½    | 18 1 0             | 0 2 27                                                     |  | { 20<br>33               | 15¾<br>11¾ | 4½<br>5 | 3 1 2<br>20 10 0*    |
| 70-pr. - -     | 14 0 0             |  | 87                     | 36       | 36     | 28 8 0             | —                                                          |  | —                        | —          | —       | —                    |
| 40-pr. - -     | 2 0 20             |  | 44                     | 14½      | 10½    | 13 1 0             | 0 2 27                                                     |  | { 20<br>33               | 15¾<br>11¾ | 4½<br>5 | 3 1 2<br>20 10 0*    |
| 20-pr. - -     | 1 1 3              |  | 42½                    | 11½      | 7½     | 10 6 1             | 0 2 27                                                     |  | { 20<br>33               | 15¾<br>11¾ | 4½<br>5 | 3 1 2<br>20 10 0*    |
| 12-pr. - -     | 0 3 21             |  | 36                     | 12½      | 7½     | 8 16 9             | 0 2 27                                                     |  | { 20<br>33               | 15¾<br>11¾ | 4½<br>5 | 3 1 2<br>20 10 0*    |
| 9-pr. - -      | 0 3 21             |  | 36                     | 12½      | 7½     | 8 13 9             | 0 2 27                                                     |  | { 20<br>33               | 15¾<br>11¾ | 4½<br>5 | 3 1 2<br>20 10 0*    |
| 6-pr. - -      | 0 2 14             |  | 32                     | 11       | 6½     | 7 10 9             | 0 2 27                                                     |  | { 20<br>33               | 15¾<br>11¾ | 4½<br>5 | 3 1 2<br>20 10 0*    |

\* Screwing Apparatus.

Royal Gun Factories,  
11th March 1863.

RETURN showing the NUMBER of ARMSTRONG GUNS (manufactured at the ROYAL GUN FACTORIES) moved and passed into the SERVICE or rejected up to the present Date.

| NATURE.                 | Total proved. | Number.                  |           | REMARKS.                                                                                       |
|-------------------------|---------------|--------------------------|-----------|------------------------------------------------------------------------------------------------|
|                         |               | Passed into the Service. | Rejected. |                                                                                                |
| 6-pr. guns - - -        | 93            | 87                       | —         | Cancelled, 4. 16/8/61. $\frac{73}{\text{G. No. 321}}$<br>In R. G. Factories not yet issued, 2. |
| 9-pr. " - - -           | 194           | 178                      | —         | In R. G. Factories not yet issued, 16.                                                         |
| 12-pr. { Land service - | 364           | 362                      | —         | Converted to sea service, 2.                                                                   |
| { Sea service -         | 260           | 257                      | —         | In R. G. Factories not yet issued, 5.                                                          |
|                         |               |                          |           | The total 12-prs. { Proved, 624.<br>{ Passed, 619.<br>{ taken together - { In Department, 5.   |
| 20-pr. { Land service - | 63            | 63                       | —         |                                                                                                |
| { Sea service -         | 256           | 256                      | —         |                                                                                                |
| 40-pr. " - - -          | 200           | 184                      | —         | In R. G. Factories not yet issued, 16.                                                         |
| 100 pr. { Light - - -   | 75            | 65                       | —         | In R. G. Factories not yet issued, 10.                                                         |
| { Heavy - - -           | 696           | 687                      | —         | In R. G. Factories not yet issued, 9.                                                          |

JOHN ANDERSON,  
Assistant Superintendent,  
Royal Gun Factories.



Inspector of Artillery's Office,  
5th March 1863.

RETURN of ARMSTRONG GUNS (manufactured at ELSWICK), showing the NUMBER proved at WOOLWICH and passed into the SERVICE or rejected to present Date.

| NATURE.           | Total proved. | Number. |           | REMARKS.                                          |
|-------------------|---------------|---------|-----------|---------------------------------------------------|
|                   |               | Passed. | Rejected. |                                                   |
| 12-pr. guns - - - | 92            | 90      | —         | 2 with Royal Gun Factories for repair.            |
| 20-pr. „ - - -    | 31            | 24      | —         | 7 do. do.                                         |
| 40-pr. „ - - -    | 571           | 562     | 6         | 3 repaired after proof, and now under inspection. |
| 110-pr. „ - - -   | 254           | 243     | 11        | —                                                 |

H. K. STRANGE, Colonel,  
Inspector of Artillery.

EVIDENCE OF LIEUT. BEST, R.A.

With reference to the answer to Query 2891, evidence.

REPORT of the Examination of 4 brass 12-pr. Whitworth guns after firing 200 rounds with service charges.

No. 128. received 17th February 1862, weight 14 cwt. 3 qrs. 10 lbs. passed as experimental, not proved:—

The bore expanded to within 49 inches of the muzzle, and deeply indented at the seat of the shot on the bearing side of the rifling from 49·5 inches to 57·3 inches.

Greatest amount of expansion. { Major diameter at 56 inches expanded ·06 inch.  
Minor diameter at 57 inches expanded ·045 inch.

Flaws in bore at 48·3 inches, "Left," ·55 inch long, ·4 inch wide, and ·1 inch deep, the metal rough all round the gun from 49 to 53 inches.

No. 129.—Received 17th February 1862, weight 14 cwt. 3 qrs. 14 lbs. passed as experimental, not proved:—

The bore expanded to within 49 inches of the muzzle and deeply indented at the seat of the shot on the bearing side of the rifling from 46·3 inches to 57·5 inches.

Greatest amount of expansion. { Minor diameter at 56 inches expanded ·14 inch.  
Major diameter at 54·5 inches expanded ·107 inch.

Flaws in the bore at 51·8 inches "Left," 1 inch long, ·35 inch wide, and ·1 inch deep, and at 52·55 inches left, ·7 inch long, ·2 inch wide, and ·15 inch deep; the metal rough all round from 48·5 inches to 54·5 inches.

No. 131.—Weight 11 cwt. 2 qrs. 16 lbs. Received 26th March 1862, proved 22nd April 1862, with 2 rounds of 3 lbs. and projectile = 12 lbs.

Examination after proof.—Bore expanded from 47 inches from the muzzle to 55 inches, the expansion being ·03 inch at the largest part.

Examination after 200 service rounds.—Bore expanded from end of bore to within 46 inches of the muzzle and deeply indented at the seat of the shot on the bearing side of the rifling from 46·5 inches from the muzzle to 57 inches.

Greatest amount of expansion. { Minor diameter at 56·5 inches expanded ·1 inch.  
Major diameter at 57 inches expanded ·087 inch.

Flaws in the bore at 54·3 inches "Up," 1 inch long, ·4 inch wide, and ·25 inch deep, from 42·3 inches to 44·3 inches "Right of Up," ·7 inch wide and ·1 inch deep, and from 44·8 inches to 46·8 inches "Right," about ·05 inch deep; the metal rough from 49 to 56 inches all round.

No. 132.—Weight 11 cwt. 3 qrs. 0 lbs., received 26th March 1862, proved 22nd April 1862, with 2 rounds of 3 lbs. and projectile = 12 lbs.

Examination after proof.—Bore expanded from 49 to 54 inches, the expansion being ·033 inches at the largest point.

Examination after firing 200 service rounds.—Bore expanded from 48 inches to end of the bore and deeply dented at the seat of the shot on the bearing side of the rifling from 46·3 to 56·8 inches.

Greatest amount of expansion. { Minor diameter at 55 inches expanded ·1 inch.  
Major diameter at 58 inches expanded ·084 inch.

Flaws in the bore at 52·3 inches "Up," 1·25 inches long, ·25 inch wide, and ·2 inch deep, at 45·3 inches "Right," 1 inch long, ·3 inch wide, and ·05 inch deep, and at 46·3 inches "Left of Up," 1·3 inches long, ·4 inch wide and ·2 inch deep; the metal rough all round from 49·3 inches to 55·3 inches.

Memorandum.—All measurements unless otherwise specified are from the muzzle.

PROGRAMME—FIELD GUNS.

GENERAL CONDITIONS.

(1.) The following practice to be carried on by 3 guns of each pattern:—

(2.) The guns to be sighted by the proposers, but afterwards verified in the Royal Gun Factory, Woolwich.

(3.) The guns to be fired from horizontal platforms.

(4.) The deflection of each shot to be measured from the 1st graze along a line at right angles to the line of fire; the deflection at the 2nd and 3rd graze to be similarly measured; the range of each graze to be noted.

(5.) The range party to go in after each round.

(6.) Should it be necessary, additional rounds, at the discretion of the Committee, to be fired; each gun to fire the same number.

RANGE.

Each gun to fire 20 rounds solid shot, 5 common shell, 5 segment or shrapnel, at each degree of elevation from 0° to 10°.

The elevation to be by spirit level.

The axis of the gun to be laid on the object, with no allowance for wind or deflection.

Sir William Armstrong and Mr. Whitworth to have the option of naming their own gun detachment for the experiments connected with accuracy and range; the Committee to verify the laying of the gun.

A parallelogram of error to be made for each gun at each elevation.

INITIAL VELOCITY AND RETARDATION.

These points to be determined during the above practice at the discretion of the Committee by Navez's instrument.

## ACCURACY.

Each gun to fire 200 rounds as follows:—

| 10 rounds at | 200 yards. | 10 rounds at | 1,300 yards. |
|--------------|------------|--------------|--------------|
| 10           | 300 "      | 10           | 1,500 "      |
| 10           | 400 "      | 10           | 1,700 "      |
| 10           | 500 "      | 10           | 1,900 "      |
| 10           | 600 "      | 10           | 2,000 "      |
| 10           | 700 "      | 10           | 2,200 "      |
| 10           | 800 "      | 10           | 2,400 "      |
| 10           | 900 "      | 10           | 2,600 "      |
| 10           | 1,000 "    | 10           | 2,800 "      |
| 10           | 1,200 "    | 10           | 3,000 "      |

The first 5 rounds at each elevation to be considered as trial shots to ascertain the proper elevation and deflection, and are therefore not to be tabulated.

Each gun to be laid at the centre of the target, with the elevation and deflection named by the proposer of the gun.

Longitudinal deviation to be tabulated as observed.

Lateral deviation to be referred to a vertical plane passing through the target at right angles to the line of sight.

Thirty rounds to be fired at different ranges under peculiar conditions of weather.

A parallelogram of error to be made for each gun at each range.

## PENETRATION.

## Rifle Pits.

- 10 solid shot,
- 10 common shell,
- 10 segment or shrapnel shell,

to be fired against some rifle pits constructed for the purpose; each pit to contain one or more wooden figures to represent men.

## Stockades.

Each gun to fire—

- 6 rounds segment or shrapnel shell,
- at a stockade made to resist musketry fire.
- Targets to be placed six feet in rear to show the effect.

## Field Works.

Each gun to fire—

- 20 solid shot,
- 20 " segment or shrapnel shell,
- 20 " common shell,

against a field work.

- Targets to be placed six feet in rear of the embrasures.
- The guns to be laid as directed by the Committee.

## DESTRUCTIVE EFFECT.

## As Common Case.

Each to name the ammunition most applicable.

| 5 rounds at | 450 yards. | 5 rounds at | 200 yards. |
|-------------|------------|-------------|------------|
| 5           | 400 "      | 5           | 100 "      |
| 5           | 300 "      | 5           | 50 "       |

## As Segment or Shrapnel Shell.

| 10 rounds at | 500 yards. | 10 rounds at | 1,600 yards. |
|--------------|------------|--------------|--------------|
| 10           | 600 "      | 10           | 1,800 "      |
| 10           | 800 "      | 10           | 2,000 "      |
| 10           | 1,000 "    | 10           | 2,200 "      |
| 10           | 1,200 "    | 10           | 3,000 "      |
| 10           | 1,400 "    |              |              |

## As Common Shell.

| 5 rounds at | 500 yards. | 5 rounds at | 2,000 yards. |
|-------------|------------|-------------|--------------|
| 5           | 1,000 "    | 5           | 2,500 "      |
| 5           | 1,500 "    | 5           | 3,000 "      |

The targets to consist of deal boards 2 inches in thickness, 6 feet in height, 60 feet in length, and to be placed in six lines representing a regiment in quarter distance column.

The targets to be examined at the conclusion of the practice at each range.

The lines of targets to be placed 25 yards on each side of a line drawn half way between the guns parallel to the line of fire.

All hits on a target to count to whoever the target is detailed for.

## In attacking Villages.

3 rounds segment or shrapnel shell at 900 yards.

|             |        |       |
|-------------|--------|-------|
| 5           | common | 900   |
| The same at | -      | 1,200 |
| "           | -      | 1,400 |
| "           | -      | 2,500 |

At a wall built of wattle and dab, such as usually found on the continent, in India, &c.

The wall to be 2 feet thick, 8 feet high, with wooden targets 6 feet in rear, to show the effect of the shell.

The same number of rounds to be fired against a brick wall under similar conditions.

The wall to be 3 bricks thick. Targets 6 feet in rear.

## Against Abbatis.

- 10 solid shot.
- 10 common shell.
- At different ranges.

## Against Rope Mantlets.

- 5 segment or shrapnel shell.
- 5 common shell.
- At different ranges.

Wooden figures of men to be placed round an un-serviceable gun carriage in the positions occupied by a gun detachment.

## Against Field Artillery.

- 20 segment or shrapnel shell.
- 20 common shell.

Two un-serviceable field guns with wooden figures representing the detachments to be fired at, at 3,000, 2,500, 2,000, 1,000, 800 yards.

## EASE OF WORKING.

This to be noted during the foregoing experiments.

## RECOIL.

This is to be measured after every round until sufficient data has been obtained.

## RAPID AND PROLONGED FIRING.

- 10 rounds segment or shrapnel shell.
- 10 " common "

The limbers to be packed for service, and the shell to be fired at different ranges.

The time to be taken from the order *load* to the last round.

200 rounds solid shot to be fired as quickly as possible in such manner as the Committee may determine.

The guns to be carefully examined at the conclusion.

## CAPABILITY OF STANDING ROUGH USAGE.

## Effect of Dirt, Mud, and Sand.

Each gun prepared ready for action, with sights, side arms, &c., to be turned over with its carriage into a muddy ditch, left there during the night, and then five rounds solid shot to be fired as quickly as possible after the gun is got out.

No scraping or cleaning to be allowed until all the guns are out of the ditch and in the same position.

Effect of embarkation and disembarkation under different circumstances and use in boats to be ascertained.

## Effect on Bore of premature Explosion of Shell.

- 5 segment or shrapnel shell,
- 5 common shell,

to be burst as near the seat of the shot as possible, each gun to be examined after each round, and at the conclusion to fire—

- 10 rounds solid shot,
- 10 " common shell,

for accuracy and range.

## Endurance.

Should the guns show no signs of weakness they are to complete 3,000 rounds in the most convenient manner, then fire 20 rounds to test their accuracy and range, to be then taken to the bursting cell at Woolwich and tested with increasing cylinders with service charge of powder as follows:—

|                    |           |
|--------------------|-----------|
| 10 rounds cylinder | = 2 shot. |
| 10 " "             | = 3 "     |
| 10 " "             | = 4 "     |
| 10 " "             | = 6 "     |

The guns complete for service, with sights, &c., fixed, to be fired at by infantry at different ranges, by artillery with common shell, segment or shrapnel shell, round shot, and common case.

## Durability of Ammunition.

- 10 solid shot,
- 10 segment or shrapnel shell,
- 10 common shell,

to be laid for a month in wet straw, and exposed to the weather, the ammunition to be then examined and fired.

The fuses, &c. to be tested by heat and damp.

A limber packed for service with each description of ammunition to be sent to Aldershot for summer drill, to test the effect of jolting.



1st August 1863.

RETURN of ARMSTRONG GUNS issued up to the above Date, showing the NUMBER of ROUNDS fired from each, the Station to which they were issued, their present State, Cost of Alteration or Repair, present Station, as far as is known at Woolwich.

Note.—When not otherwise stated the gun is serviceable. R. stands for repairable. + for unserviceable.

| No. of Gun. | Nature of Gun.      | Maker.   | Number of Rounds fired. | Station or Service for which issued. | Present State of Gun. | Cost of     |         | Present Station.      |
|-------------|---------------------|----------|-------------------------|--------------------------------------|-----------------------|-------------|---------|-----------------------|
|             |                     |          |                         |                                      |                       | Alteration. | Repair. |                       |
|             |                     |          |                         |                                      |                       | £ s. d.     | £ s. d. |                       |
| 2           | 6-pounder.—3 cwt. - | R. G. F. |                         | Bengal                               |                       |             |         | Bengal.               |
| 4           | "                   | "        |                         | Do.                                  |                       |             |         | Do.                   |
| 5           | "                   | "        |                         | Cape of Good Hope                    |                       |             |         | Cape of Good Hope.    |
| 6           | "                   | "        |                         | O.S. Committee                       |                       | 1 15 6      |         | H.M.S. "Excellent."   |
| 7           | "                   | "        | 20                      | Portsmouth                           |                       |             |         | Shoeburyness.         |
| 9           | "                   | "        |                         | Shoeburyness                         |                       |             |         | Bengal.               |
| 10          | "                   | "        |                         | Bengal                               |                       |             |         | H.M.S. "Marlborough." |
| 11          | "                   | "        |                         | Portsmouth                           |                       |             |         | Bengal.               |
| 14          | "                   | "        |                         | Bengal                               |                       |             |         | Madras.               |
| 15          | "                   | "        |                         | Madras                               |                       |             |         | Cape of Good Hope.    |
| 16          | "                   | "        | 475                     | Cape of Good Hope                    |                       |             |         | Shoeburyness.         |
| 17          | "                   | "        | 10                      | Shoeburyness                         |                       |             |         | Cape of Good Hope.    |
| 18          | "                   | "        |                         | Bengal                               |                       |             |         | Bengal.               |
| 19          | "                   | "        |                         | Do.                                  |                       |             |         | Do.                   |
| 21          | "                   | "        |                         | Madras                               |                       |             |         | Madras.               |
| 22          | "                   | "        |                         | Portsmouth                           |                       |             |         | H.M.S. "Phaeton."     |
| 23          | "                   | "        | 10                      | Do.                                  |                       |             |         | " "Edgar."            |
| 24          | "                   | "        |                         | Madras                               |                       |             |         | Madras.               |
| 25          | "                   | "        |                         | Do.                                  |                       |             |         | Do.                   |
| 26          | "                   | "        | 15                      | O.S. Committee                       |                       |             |         | Store.                |
| 27          | "                   | "        |                         | Cape of Good Hope                    |                       |             |         | Cape of Good Hope.    |
| 28          | "                   | "        |                         | Portsmouth                           |                       |             |         | Portsmouth.           |
| 29          | "                   | "        |                         | Cape of Good Hope                    |                       |             |         | Cape of Good Hope.    |
| 30          | "                   | "        |                         | Madras                               |                       |             |         | Madras.               |
| 31          | "                   | "        |                         | Cape of Good Hope                    |                       |             |         | Cape of Good Hope.    |
| 32          | "                   | "        |                         | H.M.S. "Cambridge"                   |                       |             |         | H.M.S. "Cambridge."   |
| 33          | "                   | "        |                         | Cape of Good Hope                    |                       |             |         | Cape of Good Hope.    |
| 34          | "                   | "        |                         | Madras                               |                       |             |         | Madras.               |
| 35          | "                   | "        | 10                      | Portsmouth                           |                       |             |         | H.M.S. "Phaeton."     |
| 37          | "                   | "        |                         | Cape of Good Hope                    |                       |             |         | Cape of Good Hope.    |
| 38          | "                   | "        |                         | Bombay                               |                       |             |         | Bombay.               |
| 39          | "                   | "        |                         | H.M.S. "Racehorse"                   |                       |             |         | China.                |
| 40          | "                   | "        |                         | Devonport                            |                       |             |         | H.M.S. "Revenge."     |
| 41          | "                   | "        |                         | Bombay                               |                       |             |         | Bombay.               |
| 42          | "                   | "        |                         | Do.                                  |                       |             |         | Do.                   |
| 43          | "                   | "        |                         | Do.                                  |                       |             |         | Do.                   |
| 44          | "                   | "        |                         | Do.                                  |                       |             |         | Do.                   |
| 46          | "                   | "        | 10                      | Shoeburyness                         |                       |             |         | Shoeburyness.         |
| 49          | "                   | "        |                         | Bombay                               |                       |             |         | Bombay.               |
| 53          | "                   | "        |                         | Portsmouth                           |                       |             |         | H.M.S. "Curacoa."     |
| 54          | "                   | "        |                         | Do.                                  |                       |             |         | Portsmouth.           |
| 58          | "                   | "        |                         | Devonport                            |                       |             |         | Devonport.            |
| 60          | "                   | "        |                         | Portsmouth                           |                       |             |         | Portsmouth.           |
| 63          | "                   | "        |                         | Devonport                            |                       |             |         | Devonport.            |
| 64          | "                   | "        |                         | Do.                                  |                       |             |         | Do.                   |
| 65          | "                   | "        |                         | O.S. Committee                       |                       |             |         | O.S. Committee.       |
| 66          | "                   | "        |                         | Devonport                            |                       |             |         | Devonport.            |
| 69          | "                   | "        |                         | Do.                                  |                       |             |         | Do.                   |
| 70          | "                   | "        |                         | Portsmouth                           |                       |             |         | Portsmouth.           |
| 72          | "                   | "        |                         | Devonport                            |                       |             |         | Devonport.            |
| 73          | "                   | "        |                         | Do.                                  |                       |             |         | Do.                   |
| 74          | "                   | "        |                         | Portsmouth                           |                       |             |         | Portsmouth.           |
| 75          | "                   | "        |                         | Devonport                            |                       |             |         | Devonport.            |
| 76          | "                   | "        |                         | Portsmouth                           |                       |             |         | Portsmouth.           |
| 77          | "                   | "        |                         | Devonport                            |                       |             |         | Devonport.            |
| 78          | "                   | "        |                         | Portsmouth                           |                       |             |         | Portsmouth.           |
| 81          | "                   | "        |                         | Chatham                              |                       |             |         | Chatham.              |
| 84          | "                   | "        |                         | Devonport                            |                       |             |         | Devonport.            |
| 85          | "                   | "        |                         | Chatham                              |                       |             |         | Chatham.              |
| 86          | "                   | "        |                         | Do.                                  |                       |             |         | Do.                   |
| 92          | "                   | "        |                         | Portsmouth                           |                       |             |         | Portsmouth.           |
| 95          | "                   | "        |                         | Do.                                  |                       |             |         | Do.                   |
| 1           | 9-pounder.—6 cwt. - | R. G. F. | 329                     | Shoeburyness                         |                       |             |         | Shoeburyness.         |
| 2           | "                   | "        | 295                     | Do.                                  |                       | 6 1 2       |         | F. Battery, R.H.A.    |
| 3           | "                   | "        |                         | F. Battery, R.H.A.                   |                       |             |         |                       |
| 4           | "                   | "        |                         | G. "                                 |                       |             |         | G. "                  |
| 5           | "                   | "        |                         | G. "                                 |                       | 6 14 2      | 0 13 9  |                       |
| 6           | "                   | "        |                         | G. "                                 |                       | 15 10 7     |         |                       |
| 7           | "                   | "        | 200                     | A. "                                 |                       |             |         | A. "                  |
| 8           | "                   | "        |                         | G. "                                 |                       | 15 3 11     | 1 5 4   | G. "                  |
| 9           | "                   | "        |                         | G. "                                 |                       |             |         |                       |
| 10          | "                   | "        | 52                      | K. "                                 |                       | 6 12 6      | 0 3 9   |                       |
| 11          | "                   | "        |                         |                                      |                       |             |         |                       |
| 12          | "                   | "        | 52                      | K. "                                 |                       |             |         | K                     |
| 13          | "                   | "        | 46                      | K. "                                 |                       |             |         |                       |
| 14          | "                   | "        | 46                      | K. "                                 |                       | 4 12 9      | 0 3 9   |                       |
| 15          | "                   | "        | 52                      | K. "                                 |                       | 8 1 11      | 0 11 2  |                       |

N.B.—This return does not include guns which have not been issued.

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun.      | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.    |
|-------------------|---------------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|---------------------|
|                   |                     |          |                                  |                                            |                                | Alteration. | Repair. |                     |
|                   |                     |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                     |
| 16                | 9-pounder.—6 cwt. - | R. G. F. | 200                              | A. Battery, R.H.A. -                       |                                |             |         | A. Battery, R.H.A.  |
| 17                | " " -               | "        | 52                               | K. " " -                                   |                                |             |         | K. " "              |
| 19                | " " -               | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.         |
| 20                | " " -               | "        | 200                              | A. Battery, R.H.A. -                       |                                |             |         | A. Battery, R.H.A.  |
| 22                | " " -               | "        |                                  | B. " " -                                   |                                |             |         |                     |
| 23                | " " -               | "        |                                  | B. " " -                                   |                                |             |         |                     |
| 24                | " " -               | "        |                                  | B. " " -                                   |                                |             |         | B. " "              |
| 26                | " " -               | "        | 380                              | B. " " -                                   | R                              |             |         |                     |
| 27                | " " -               | "        |                                  | A. " " -                                   |                                |             |         | A. " "              |
| 28                | " " -               | "        | 200                              | A. " " -                                   |                                |             |         | B. " "              |
| 29                | " " -               | "        |                                  | B. " " -                                   |                                |             |         |                     |
| 30                | " " -               | "        |                                  | A. " " -                                   |                                |             |         | A. " "              |
| 32                | " " -               | "        |                                  | A. " " -                                   |                                |             |         |                     |
| 33                | " " -               | "        | 377                              | D. " " -                                   |                                |             |         | D. " "              |
| 34                | " " -               | "        | 377                              | D. " " -                                   |                                |             |         |                     |
| 35                | " " -               | "        | 295                              | D. " " -                                   |                                |             |         | Depôt               |
| 36                | " " -               | "        | 231                              | H. " " -                                   |                                |             |         | "                   |
| 37                | " " -               | "        | 448                              | D. " " -                                   |                                |             |         | D. Battery          |
| 38                | " " -               | "        | 295                              | D. " " -                                   |                                |             |         | "                   |
| 39                | " " -               | "        | 235                              | H. " " -                                   |                                |             |         | Depôt               |
| 40                | " " -               | "        | 493                              | D. " " -                                   |                                |             |         | D. Battery          |
| 41                | " " -               | "        | 233                              | H. " " -                                   |                                |             |         | "                   |
| 42                | " " -               | "        | 171                              | H. " " -                                   |                                |             |         | Depôt               |
| 43                | " " -               | "        |                                  | H. " " -                                   |                                |             |         | "                   |
| 44                | " " -               | "        |                                  | H. " " -                                   |                                |             |         |                     |
| 45                | " " -               | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Excellent." |
| 46                | " " -               | "        | 25                               | Devonport -                                |                                |             |         | Devonport.          |
| 47                | " " -               | "        | 187                              | J. Battery, R.H.A. -                       |                                |             |         |                     |
| 48                | " " -               | "        | 187                              | J. " " -                                   |                                |             |         | J. Battery, R.H.A.  |
| 49                | " " -               | "        | 182                              | J. " " -                                   |                                |             |         |                     |
| 50                | " " -               | "        | 182                              | J. " " -                                   |                                |             |         |                     |
| 51                | " " -               | "        | 181                              | C. " " -                                   |                                |             |         | C. " "              |
| 52                | " " -               | "        |                                  | C. " " -                                   |                                |             |         | "                   |
| 53                | " " -               | "        | 181                              | J. " " -                                   |                                |             |         | J. " "              |
| 54                | " " -               | "        | 94                               | E. " " -                                   |                                |             |         |                     |
| 55                | " " -               | "        | 94                               | E. " " -                                   |                                |             |         | E. " "              |
| 56                | " " -               | "        |                                  | E. " " -                                   |                                |             |         |                     |
| 57                | " " -               | "        |                                  | C. " " -                                   |                                |             |         |                     |
| 58                | " " -               | "        |                                  | C. " " -                                   |                                |             |         | C. " "              |
| 59                | " " -               | "        |                                  | C. " " -                                   |                                |             |         | "                   |
| 60                | " " -               | "        |                                  | C. " " -                                   |                                |             |         |                     |
| 61                | " " -               | "        |                                  | C. " " -                                   |                                |             |         |                     |
| 62                | " " -               | "        | 95                               | E. " " -                                   |                                |             |         | E. " "              |
| 63                | " " -               | "        |                                  | E. " " -                                   |                                |             |         | "                   |
| 64                | " " -               | "        | 93                               | E. " " -                                   |                                |             |         |                     |
| 65                | " " -               | "        | 81                               | F. " " -                                   |                                |             |         |                     |
| 66                | " " -               | "        |                                  | F. " " -                                   |                                |             |         | F. " "              |
| 67                | " " -               | "        |                                  | F. " " -                                   |                                |             |         | "                   |
| 68                | " " -               | "        | 141                              | F. " " -                                   |                                |             |         |                     |
| 69                | " " -               | "        | 81                               | F. " " -                                   |                                |             |         |                     |
| 71                | " " -               | "        | 10                               | Shoeburyness                               |                                |             |         | Shoeburyness.       |
| 73                | " " -               | "        | 20                               | Do. -                                      |                                |             |         |                     |
| 74                | " " -               | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.         |
| 76                | " " -               | "        |                                  | Do. -                                      |                                |             |         |                     |
| 80                | " " -               | "        |                                  | Do. -                                      |                                |             |         |                     |
| 83                | " " -               | "        |                                  | Depôt, R.H.A. -                            |                                |             |         | Store.              |
| 88                | " " -               | "        |                                  | Do. -                                      |                                |             |         |                     |
| 89                | " " -               | "        |                                  | Do. -                                      |                                |             |         |                     |
| 90                | " " -               | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.         |
| 91                | " " -               | "        |                                  | Do. -                                      |                                |             |         |                     |
| 92                | " " -               | "        |                                  | B. Battery, R.H.A. -                       |                                |             |         | B. Battery, R.H.A.  |
| 95                | " " -               | "        |                                  | Devonport -                                |                                |             |         | Devonport.          |
| 96                | " " -               | "        |                                  | Depôt, R.H.A. -                            |                                |             |         | Store.              |
| 99                | " " -               | "        |                                  | H. Battery, R.H.A. -                       |                                |             |         | H. Battery, R.H.A.  |
| 100               | " " -               | "        |                                  | H. " " -                                   |                                |             |         | Do.                 |
| 101               | " " -               | "        |                                  | Depôt, R.H.A. -                            |                                |             |         | Store.              |
| 102               | " " -               | "        |                                  | H. Battery, R.H.A. -                       |                                |             |         | H. Battery, R.H.A.  |
| 103               | " " -               | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.         |
| 104               | " " -               | "        |                                  | Devonport -                                |                                |             |         | Devonport.          |
| 105               | " " -               | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.         |
| 107               | " " -               | "        |                                  | Devonport -                                |                                |             |         | Devonport.          |
| 108               | " " -               | "        |                                  | Depôt, R.H.A. -                            |                                |             |         | Store.              |
| 109               | " " -               | "        |                                  | H. Battery, R.H.A. -                       |                                |             |         | H. Battery, R.H.A.  |
| 110               | " " -               | "        |                                  | Devonport -                                |                                |             |         | Devonport.          |
| 112               | " " -               | "        |                                  | Do. -                                      |                                |             |         |                     |
| 113               | " " -               | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Esk."       |
| 114               | " " -               | "        |                                  | Devonport -                                |                                |             |         | Devonport.          |
| 115               | " " -               | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Curagoa."   |
| 116               | " " -               | "        |                                  | Devonport -                                |                                |             |         |                     |
| 117               | " " -               | "        |                                  | Do. -                                      |                                |             |         | Devonport.          |
| 118               | " " -               | "        |                                  | Do. -                                      |                                |             |         |                     |
| 119               | " " -               | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.         |
| 120               | " " -               | "        |                                  | Devonport -                                |                                |             |         | Devonport.          |
| 121               | " " -               | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.         |
| 122               | " " -               | "        |                                  | Devonport -                                |                                |             |         | Devonport.          |
| 123               | " " -               | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.         |
| 124               | " " -               | "        |                                  | Devonport -                                |                                |             |         | Devonport.          |



Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun.        | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gnn. | Cost of     |         | Present Station.       |
|-------------------|-----------------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|------------------------|
|                   |                       |          |                                  |                                            |                                | Alteration. | Repair. |                        |
|                   |                       |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                        |
| 125               | 9-pounder.—6 cwt. -   | R. G. F. |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 126               | " " -                 | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 127               | " " -                 | "        |                                  | H. Battery, R.H.A. -                       |                                |             |         | H. Battery, R.H.A.     |
| 128               | " " -                 | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 130               | " " -                 | "        |                                  | Portsmouth -                               |                                |             |         | } Portsmouth.          |
| 131               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 132               | " " -                 | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 134               | " " -                 | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 136               | " " -                 | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 137               | " " -                 | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 138               | " " -                 | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 139               | " " -                 | "        |                                  | Chatham -                                  |                                |             |         | } Chatham.             |
| 140               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 141               | " " -                 | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 143               | " " -                 | "        |                                  | H. Battery, R.H.A. -                       |                                |             |         | H. Battery, R.H.A.     |
| 144               | " " -                 | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 145               | " " -                 | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 146               | " " -                 | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 147               | " " -                 | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Cossack."      |
| 148               | " " -                 | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 149               | " " -                 | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 151               | " " -                 | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 152               | " " -                 | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 153               | " " -                 | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Royal Oak."    |
| 154               | " " -                 | "        |                                  | Do. -                                      |                                |             |         | Chatham.               |
| 155               | " " -                 | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 157               | " " -                 | "        |                                  | Devonport -                                |                                |             |         | } Devonport.           |
| 158               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 160               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 161               | " " -                 | "        |                                  | Do. -                                      |                                |             |         | } Portsmouth.          |
| 162               | " " -                 | "        |                                  | Portsmouth -                               |                                |             |         |                        |
| 165               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 167               | " " -                 | "        |                                  | Do. -                                      |                                |             |         | } Chatham.             |
| 168               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 169               | " " -                 | "        |                                  | Chatham -                                  |                                |             |         |                        |
| 170               | " " -                 | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 171               | " " -                 | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 172               | " " -                 | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 173               | " " -                 | "        |                                  | Devonport -                                |                                |             |         | } Devonport.           |
| 175               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 177               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 179               | " " -                 | "        |                                  | Do. -                                      |                                |             |         | } Chatham.             |
| 182               | " " -                 | "        |                                  | Chatham -                                  |                                |             |         |                        |
| 183               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 184               | " " -                 | "        |                                  | Devonport -                                |                                |             |         | } Devonport.           |
| 186               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 188               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 189               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 191               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 192               | " " -                 | "        |                                  | Do. -                                      |                                |             |         | } Chatham.             |
| 193               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 195               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
| 198               | " " -                 | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 199               | " " -                 | "        |                                  | Devonport -                                |                                |             |         | } Devonport.           |
| 201               | " " -                 | "        |                                  | Do. -                                      |                                |             |         |                        |
|                   |                       |          |                                  |                                            |                                |             |         |                        |
| 1                 | 12-pr. L.S.—8½ cwt. - | R. G. F. | 819                              | Devonport -                                | R                              |             |         | Devonport.             |
| 2                 | " " -                 | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Conqueror."    |
| 3                 | " " -                 | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Miranda."      |
| 4                 | " " -                 | "        | 487                              | Do. -                                      | E                              |             |         | Store.                 |
| 5                 | " " -                 | "        |                                  | J. Battery, R.H.A. -                       |                                | 6 14 2      | 0 13 9  | } Store.               |
| 6                 | " " -                 | "        | 1,953                            | Shoeburyness -                             |                                | 15 10 7     | - - -   |                        |
| 7                 | " " -                 | "        | 3,263                            | Do. -                                      |                                |             |         | Store.                 |
| 8                 | " " -                 | "        | 191                              | Do. -                                      |                                | 15 3 11     | 1 5 6   | } Shoeburyness.        |
| 9                 | " " -                 | "        | 45                               | Do. -                                      |                                |             |         |                        |
| 10                | " " -                 | "        |                                  | 4 Battery, 4 Brigade                       |                                |             |         | 4 Battery, 4 Brigade.  |
| 11                | " " -                 | "        |                                  | 7 " " -                                    |                                | 6 12 6      | 0 3 9   | Store.                 |
| 12                | " " -                 | "        | 50                               | 7 " " -                                    |                                | 6 12 6      | 0 3 9   | H. Battery, 9 Brigade. |
| 13                | " " -                 | "        | 44                               | 4 " " -                                    |                                |             |         | 4 " " -                |
| 14                | " " -                 | "        |                                  | New Zealand                                |                                |             |         | New Zealand.           |
| 15                | " " -                 | "        |                                  | K. Battery, R.H.A. -                       |                                | 4 12 9      | 0 3 9   | Store.                 |
| 16                | " " -                 | "        |                                  | J. " " -                                   |                                | 8 1 11      | 0 11 2  | B. Battery, 9 Brigade. |
| 17                | " " -                 | "        |                                  | New Zealand                                |                                |             |         | New Zealand.           |
| 18                | " " -                 | "        |                                  | 8 Battery, 8 Brigade                       |                                | 10 13 6     | 0 4 6   | Store.                 |
| 19                | " " -                 | "        | 1,515                            | Shoeburyness                               |                                |             |         | Store.                 |
| 20                | " " -                 | "        |                                  | K. Battery, R.H.A. -                       |                                | 8 4 11      | 0 4 6   | Store.                 |
| 21                | " " -                 | "        |                                  | Commandant                                 |                                | 6 2 7       | - - -   | Roy. Mil. Repository.  |
| 22                | " " -                 | "        |                                  | New Zealand                                |                                |             |         | New Zealand.           |
| 23                | " " -                 | "        |                                  | H.M.S. "Challenger"                        |                                |             |         | H.M.S. "Challenger."   |
| 24                | " " -                 | "        | 50                               | K. Battery, R.H.A. -                       |                                | 15 8 3      | - - -   | H. Battery, 9 Brigade. |
| 25                | " " -                 | "        |                                  | Do. -                                      |                                |             |         | Store.                 |
|                   | " " -                 | "        |                                  | R. M. Academy -                            |                                | 6 2 7       | - - -   | Woolwich.              |

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun.       | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of          |                   | Present Station.       |
|-------------------|----------------------|----------|----------------------------------|--------------------------------------------|--------------------------------|------------------|-------------------|------------------------|
|                   |                      |          |                                  |                                            |                                | Alteration.      | Repair.           |                        |
| 26                | 12-pr. L.S.—8½ cwt.— | R. G. F. |                                  | K. Battery, R.H.A. -                       |                                | £ s. d.<br>8 6 4 | £ s. d.<br>0 16 3 | Store.                 |
| 27                | " " " "              | "        |                                  | Do. " " " "                                |                                | 9 9 8            | 0 17 3            |                        |
| 28                | " " " "              | "        |                                  | 8 Battery, 8 Brigade                       |                                | 11 8 2           | 0 6 0             |                        |
| 29                | " " " "              | "        |                                  | 8 " " " "                                  |                                | 11 8 2           | 0 5 6             | 2 Battery, 4 Brigade.  |
| 30                | " " " "              | "        |                                  | 2 " " " "                                  |                                |                  |                   |                        |
| 31                | " " " "              | "        | 510                              | Shoeburyness -                             |                                | 11 14 0          | 0 13 10           | Shoeburyness.          |
| 32                | " " " "              | "        |                                  | Do. " " " "                                |                                |                  |                   |                        |
| 33                | " " " "              | "        | 229                              | 8 Battery, 4 Brigade                       |                                |                  |                   | C. Battery, 9 Brigade. |
| 34                | " " " "              | "        |                                  | 1 " " " "                                  |                                |                  |                   |                        |
| 35                | " " " "              | "        | 442                              | Shoeburyness -                             |                                | 11 7 2           | 0 8 9             | Store.                 |
| 36                | " " " "              | "        |                                  | 8 Battery, 8 Brigade                       |                                | 11 8 2           | 0 8 9             |                        |
| 37                | " " " "              | "        |                                  | Do. " " " "                                |                                |                  |                   | Store.                 |
| 38                | " " " "              | "        |                                  | New Zealand                                |                                |                  |                   |                        |
| 39                | " " " "              | "        |                                  | 7 Battery, 4 Brigade                       |                                | 10 7 10          | 0 4 6             | Store.                 |
| 40                | " " " "              | "        |                                  | 7 " " " "                                  |                                | 10 9 0           | 0 16 3            |                        |
| 41                | " " " "              | "        |                                  | 5 " " " "                                  |                                | 10 9 0           | 0 17 3            |                        |
| 42                | " " " "              | "        |                                  | 5 " " " "                                  |                                | 10 7 0           | 0 17 3            | 2 Battery, 4 Brigade.  |
| 43                | " " " "              | "        |                                  | 2 " " " "                                  |                                |                  |                   |                        |
| 44                | " " " "              | "        |                                  | 5 " " " "                                  |                                | 6 1 2            | - - -             | Sandhurst.             |
| 45                | " " " "              | "        | 972                              | Shoeburyness -                             |                                |                  |                   | Store.                 |
| 46                | " " " "              | "        |                                  | Do. " " " "                                |                                | 10 1 10          | 0 4 10            |                        |
| 47                | " " " "              | "        | 1,911                            | New Zealand                                |                                |                  |                   | Store.                 |
| 48                | " " " "              | "        |                                  | 5 Battery, 8 Brigade                       |                                | 10 18 9          | 0 5 6             |                        |
| 49                | " " " "              | "        |                                  | New Zealand                                |                                |                  |                   | Store.                 |
| 50                | " " " "              | "        |                                  | 2 Battery, 4 Brigade                       |                                |                  |                   |                        |
| 51                | " " " "              | "        |                                  | 7 " " " "                                  |                                | 10 18 10         | 0 5 6             | Store.                 |
| 52                | " " " "              | "        |                                  | 5 " " " "                                  |                                | 11 0 8           | 0 5 6             |                        |
| 53                | " " " "              | "        | 380                              | Shoeburyness -                             |                                |                  |                   | Shoeburyness.          |
| 54                | " " " "              | "        |                                  | Do. " " " "                                |                                |                  |                   |                        |
| 55                | " " " "              | "        | 100                              | 8 Battery, 4 Brigade                       |                                | 10 13 9          | - - -             | C. Battery, 9 Brigade. |
| 56                | " " " "              | "        |                                  | J. " " R.H.A. -                            |                                | 11 0 9           | 0 12 0            |                        |
| 57                | " " " "              | "        |                                  | 7 " " " "                                  |                                | 6 2 0            | - - -             | Store.                 |
| 58                | " " " "              | "        | 894                              | J. " " R.H.A. -                            |                                |                  |                   |                        |
| 59                | " " " "              | "        |                                  | Shoeburyness                               |                                | 4 7 7            | 0 12 6            | Store.                 |
| 60                | " " " "              | "        |                                  | C. Batt. Depot Brig.                       |                                | 8 4 0            | 0 6 6             |                        |
| 61                | " " " "              | "        | 45                               | J. Battery, R.H.A. -                       |                                |                  |                   | 4 Battery, 4 Brigade.  |
| 62                | " " " "              | "        |                                  | 4 " " " "                                  |                                | 6 2 0            | - - -             |                        |
| 63                | " " " "              | "        |                                  | J. " " R.H.A. -                            |                                |                  |                   | Portsmouth.            |
| 64                | " " " "              | "        |                                  | Portsmouth                                 |                                | 9 10 3           | 0 6 0             |                        |
| 65                | " " " "              | "        | 100                              | J. " " R.H.A. -                            |                                | 7 17 0           | - - -             | Store.                 |
| 66                | " " " "              | "        |                                  | Portsmouth                                 |                                |                  |                   |                        |
| 67                | " " " "              | "        | 250                              | 2 Battery, 9 Brigade                       |                                |                  |                   | 2 Battery, 9 Brigade.  |
| 68                | " " " "              | "        | 150                              | 4 " " " "                                  |                                |                  |                   |                        |
| 69                | " " " "              | "        | 50                               | 2 " " " "                                  |                                | 6 2 0            | - - -             | 4 " " " "              |
| 70                | " " " "              | "        |                                  | 2 " " " "                                  |                                |                  |                   |                        |
| 71                | " " " "              | "        | 100                              | 1 " " " "                                  |                                | 10 2 10          | 0 5 6             | Store.                 |
| 72                | " " " "              | "        |                                  | 1 " " " "                                  |                                | 10 3 9           | 0 5 9             |                        |
| 73                | " " " "              | "        | 100                              | 1 " " " "                                  |                                |                  |                   | H. Battery, 9 Brigade. |
| 74                | " " " "              | "        | 280                              | 2 " " " "                                  |                                |                  |                   |                        |
| 75                | " " " "              | "        | 100                              | 1 " " " "                                  |                                | 9 14 10          | 0 4 6             | Store.                 |
| 76                | " " " "              | "        | 50                               | 2 " " " "                                  |                                |                  |                   |                        |
| 77                | " " " "              | "        | 100                              | 1 " " " "                                  |                                | 9 8 6            | 0 6 0             | 2 Battery, 9 Brigade.  |
| 78                | " " " "              | "        |                                  | J. " " R.H.A. -                            |                                | 8 6 0            | 0 6 6             |                        |
| 79                | " " " "              | "        |                                  | C. " " " "                                 |                                | 4 18 9           | - - -             | Store.                 |
| 80                | " " " "              | "        |                                  | J. " " R.H.A. -                            |                                | 5 15 10          | 0 11 6            |                        |
| 81                | " " " "              | "        |                                  | J. " " " "                                 |                                | 2 8 9            | 2 14 1            | C. Battery, 9 Brigade. |
| 82                | " " " "              | "        |                                  | C. " " Depot                               |                                | 4 6 9            | 0 4 6             |                        |
| 83                | " " " "              | "        | 200                              | 8 " " " "                                  |                                | 10 5 0           | 0 1 6             | Store.                 |
| 84                | " " " "              | "        | 100                              | 1 " " " "                                  |                                |                  |                   |                        |
| 85                | " " " "              | "        | 100                              | 8 " " " "                                  |                                |                  |                   | C. Battery, 9 Brigade. |
| 86                | " " " "              | "        |                                  | New Zealand                                |                                |                  |                   |                        |
| 87                | " " " "              | "        |                                  | B. Battery, R.H.A. -                       |                                | 6 2 0            | - - -             | Fort Cumberland.       |
| 88                | " " " "              | "        |                                  | Fort Cumberland                            |                                |                  |                   |                        |
| 89                | " " " "              | "        | 170                              | 3 Battery, 4 Brigade                       |                                | 9 11 4           | 0 3 0             | Store.                 |
| 90                | " " " "              | "        |                                  | Shoeburyness                               |                                |                  |                   |                        |
| 91                | " " " "              | "        |                                  | B. Battery, R.H.A. -                       |                                | 6 2 0            | - - -             | Fort Cumberland.       |
| 92                | " " " "              | "        |                                  | Fort Cumberland                            |                                |                  |                   |                        |
| 93                | " " " "              | "        | 100                              | 8 Battery, 4 Brigade                       |                                |                  |                   | C. Battery, 9 Brigade. |
| 94                | " " " "              | "        |                                  | B. " " R.H.A. -                            |                                | 6 2 0            | - - -             |                        |
| 95                | " " " "              | "        |                                  | E. " " " "                                 |                                |                  |                   | E. " " " "             |
| 96                | " " " "              | "        |                                  | 3 " " " "                                  |                                |                  |                   |                        |
| 97                | " " " "              | "        | 31                               | O. S. Committee                            |                                | 6 2 0            | - - -             | Store.                 |
| 98                | " " " "              | "        |                                  | A. Battery, 9 Brigade                      |                                |                  |                   |                        |
| 99                | " " " "              | "        |                                  | B. " " R.H.A. -                            |                                | 8 14 6           | - - -             | Store.                 |
| 100               | " " " "              | "        | 10                               | B. " " " "                                 |                                | 11 3 6           | 0 7 9             |                        |
|                   | " " " "              | "        |                                  | O. S. Committee                            |                                |                  |                   | Store.                 |
|                   | " " " "              | "        |                                  | B. Battery, R.H.A. -                       |                                | 8 15 3           | - - -             |                        |
|                   | " " " "              | "        |                                  | D. " " " "                                 |                                |                  |                   | Store.                 |
|                   | " " " "              | "        |                                  | 8 B. 4 B., R.A. -                          |                                |                  |                   |                        |
|                   | " " " "              | "        | 121                              | 6 " " " "                                  |                                |                  |                   | C. B. 9 B. R.A.        |
|                   | " " " "              | "        | 15                               | 6 " " " "                                  |                                |                  |                   |                        |
|                   | " " " "              | "        | 15                               | 6 " " " "                                  |                                |                  |                   | 6 B. 4 B. "            |
|                   | " " " "              | "        | 180                              | 2 B. 9 B., R.A. -                          |                                |                  |                   |                        |
|                   | " " " "              | "        | 39                               | 4 B. 4 B. " "                              |                                |                  |                   | 2 B. 9 B. "            |
|                   | " " " "              | "        | 15                               | 6 " " " "                                  |                                |                  |                   |                        |
|                   | " " " "              | "        | 1,276                            | Shoeburyness                               |                                | 6 2 0            | - - -             | Store.                 |
|                   | " " " "              | "        |                                  | 3 B. 4 B., R.A. -                          |                                |                  |                   |                        |
|                   | " " " "              | "        | 219                              | 3 " " " "                                  |                                | 5 2 7            | 0 4 6             | Portsmouth.            |
|                   | " " " "              | "        |                                  | Shoeburyness                               |                                |                  |                   |                        |
|                   | " " " "              | "        |                                  |                                            |                                |                  |                   | Devonport.             |



Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun.       | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of           |                  | Present Station.     |
|-------------------|----------------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------------|------------------|----------------------|
|                   |                      |          |                                  |                                            |                                | Alteration.       | Repair.          |                      |
| 101               | 12-pr. L.S.—8½ cwt.— | R. G. F. |                                  | A. Battery R.H.A. -                        |                                | £ s. d.<br>13 2 6 | £ s. d.<br>0 4 0 | Devonport.           |
| 102               | "                    | "        |                                  | C. " R.A. -                                |                                | 4 13 9            | 0 12 0           | Store.               |
| 103               | "                    | "        |                                  | A. " R.H.A. -                              |                                | 11 8 0            | 0 4 0            | Devonport.           |
| 104               | "                    | "        | 15                               | 6 B. 4 B. R.A. -                           |                                |                   |                  | 6 B. 4 B. R.A.       |
| 105               | "                    | "        |                                  | A. B. R.H.A. -                             |                                | 5 6 0             | 0 4 0            | Store.               |
| 106               | "                    | "        | 64                               | 2 B. 8 B. R.A. -                           |                                |                   |                  | 2 B. 8 B. R.A.       |
| 107               | "                    | "        |                                  | A. B. R.H.A. -                             |                                | 7 0 6             | 0 3 6            | Store.               |
| 108               | "                    | "        | 44                               | 4 B. 4 B. R.A. -                           |                                |                   |                  | 4 B. 4 B. R.A.       |
| 109               | "                    | "        | 15                               | 6 B. " -                                   |                                |                   |                  | 6 B. " "             |
| 110               | "                    | "        | 50                               | 8 B. 8 B. " -                              |                                | 11 13 4           | 0 4 6            | Store.               |
| 111               | "                    | "        |                                  | A. B. R.H.A. -                             |                                | 7 2 6             | 0 3 6            | Store.               |
| 112               | "                    | "        |                                  | " 9 B. R.A. -                              |                                |                   |                  | A. B. 9 B. R.A.      |
| 113               | "                    | "        | 15                               | 6 B. 4 B. " -                              |                                |                   |                  | 6 " 4 " "            |
| 114               | "                    | "        |                                  | A. B. 8 B. " -                             |                                |                   |                  | A. " 8 " "           |
| 115               | "                    | "        | 983                              | Shoeburyness -                             |                                |                   |                  | Store.               |
| 116               | "                    | "        |                                  | G. B. 4 B. R.A. -                          |                                |                   |                  | G. B. 4 B. R.A.      |
| 117               | "                    | "        |                                  | E. " 8 " -                                 |                                | 11 5 0            | 0 4 0            | Store.               |
| 118               | "                    | "        |                                  | 5 " 4 " -                                  |                                | 7 13 4            | 0 8 0            | Do.                  |
| 119               | "                    | "        | 993                              | Shoeburyness -                             | R                              |                   |                  | Store.               |
| 120               | "                    | "        |                                  | 5 B. 4 B. R.A. -                           |                                | 10 4 10           | 0 8 0            | Do.                  |
| 121               | "                    | "        |                                  | K. " " -                                   |                                |                   |                  | J. B. 4 B. R.A.      |
| 122               | "                    | "        |                                  | 5 " " -                                    |                                | 13 6 9            | 0 8 0            | Store.               |
| 123               | "                    | "        |                                  | 5 " " -                                    |                                | 9 15 3            | 0 5 9            | Do.                  |
| 124               | "                    | "        | 200                              | 2 " 9 " -                                  |                                |                   |                  | 2 B. 9 B. R.A.       |
| 125               | "                    | "        | 606                              | O. S. Committee -                          |                                | 9 18 10           | 0 6 0            | Shoeburyness.        |
| 126               | "                    | "        |                                  | 5 B. 4 B. R.A. -                           |                                | 10 5 4            | 0 8 0            | Store.               |
| 127               | "                    | "        |                                  | " " " -                                    |                                |                   |                  | Do.                  |
| 128               | "                    | "        | 29                               | 4 " " -                                    |                                |                   |                  | 4 B. 4 B. R.A.       |
| 129               | "                    | "        | 60                               | Shoeburyness -                             |                                | 10 19 6           | 0 3 6            | Store short.         |
| 130               | "                    | "        |                                  | Fort Cumberland -                          |                                |                   |                  | Fort Cumberland.     |
| 131               | "                    | "        | 97                               | 2 B. 8 B. R.A. -                           |                                |                   |                  | 2 B. 8 B. R.A.       |
| 132               | "                    | "        | 50                               | " " " -                                    |                                | 8 17 3            | - - -            | Do.                  |
| 133               | "                    | "        |                                  | 3 B. 4 B. " -                              |                                |                   |                  | Store.               |
| 134               | "                    | "        |                                  | D. B. R.H.A. -                             |                                |                   |                  | R.A., Warley.        |
| 135               | "                    | "        |                                  | R.A., Warley -                             |                                |                   |                  | K. B. 4 B. R.A.      |
| 136               | "                    | "        | 50                               | K. B. 4 B. R.A. -                          |                                |                   |                  | H. B. 9 " "          |
| 137               | "                    | "        |                                  | 2 " " -                                    |                                |                   |                  | K. B. 4 " "          |
| 138               | "                    | "        |                                  | K. " " -                                   |                                | 17 10 6           | 0 6 0            | Store.               |
| 139               | "                    | "        |                                  | J. B. R.H.A. -                             |                                |                   | 1 1 0            | Proving vent pieces. |
| 140               | "                    | "        | 516                              | 3 B. 4 B. R.A. -                           |                                |                   |                  | Fort Cumberland.     |
| 141               | "                    | "        |                                  | Horse Brigade -                            |                                |                   |                  | 8 B. 4 B. R.A.       |
| 142               | "                    | "        |                                  | Fort Cumberland -                          |                                |                   |                  | Store.               |
| 143               | "                    | "        |                                  | 8 B. 4 B. R.A. -                           |                                | 4 10 9            | 0 6 0            | Devonport.           |
| 144               | "                    | "        |                                  | Depôt, R.H.A. -                            | R                              | 4 9 0             | 0 6 6            | Store.               |
| 145               | "                    | "        |                                  | Do. -                                      | R                              | 6 2 0             | - - -            | K. B. 4 B. R.A.      |
| 146               | "                    | "        | 105                              | K. B. 4 B. R.A. -                          |                                |                   |                  | Fort Cumberland.     |
| 147               | "                    | "        |                                  | " " " -                                    |                                |                   |                  | 6 B. 8 B. R.A.       |
| 148               | "                    | "        |                                  | Fort Cumberland -                          |                                |                   |                  | G.B. 4 " "           |
| 149               | "                    | "        | 132                              | 6 B. 8 B. R.A. -                           |                                |                   |                  | 7 " 8 " "            |
| 150               | "                    | "        |                                  | G. B. 4 B. R.A. -                          |                                |                   |                  | Store.               |
| 151               | "                    | "        | 150                              | 7 " 8 " -                                  |                                | 8 17 7            | - - -            | O. S. Committee.     |
| 152               | "                    | "        |                                  | B. B. R.H.A. -                             |                                | 6 2 0             | - - -            | Commandant.          |
| 153               | "                    | "        | 200                              | E. B. 9 B. R.A. -                          | +                              |                   |                  | Store.               |
| 154               | "                    | "        |                                  | Commandant -                               |                                | 14 0 4            | - - -            | Sheerness.           |
| 155               | "                    | "        |                                  | O. S. Committee -                          |                                |                   |                  | Store short.         |
| 156               | "                    | "        |                                  | Do. -                                      |                                |                   |                  | Fort Cumberland.     |
| 157               | "                    | "        | 60                               | Sheerness -                                |                                | 10 10 9           | - - -            | 1 B. 4 B. R.A.       |
| 158               | "                    | "        |                                  | Shoeburyness -                             |                                |                   |                  | 5 " 9 " "            |
| 159               | "                    | "        |                                  | Fort Cumberland -                          |                                |                   |                  | 6 " 8 " "            |
| 160               | "                    | "        | 150                              | 7 B. 8 B. R.A. -                           |                                |                   |                  | Store.               |
| 161               | "                    | "        | 100                              | 5 " 9 " -                                  |                                | 4 9 3             | 0 4 6            | Do.                  |
| 162               | "                    | "        | 66                               | 6 " 8 " -                                  |                                | 6 12 7            | 0 6 6            | Jersey.              |
| 163               | "                    | "        |                                  | Depôt, R.H.A. -                            |                                |                   |                  | E. B. 4 B. R.A.      |
| 164               | "                    | "        | 137                              | Shoeburyness -                             |                                |                   |                  | K. " "               |
| 165               | "                    | "        |                                  | Jersey -                                   |                                |                   |                  | Store.               |
| 166               | "                    | "        |                                  | E. B. 4 B. R.A. -                          |                                |                   |                  | Jersey.              |
| 167               | "                    | "        |                                  | K. " " -                                   |                                | 4 9 3             | 0 6 0            | 6 B. 9 B. R.A.       |
| 168               | "                    | "        |                                  | Depôt, R.H.A. -                            |                                | 6 2 0             | - - -            | 1 B. 4 " "           |
| 169               | "                    | "        |                                  | Shoeburyness -                             |                                |                   |                  | 3 B. 8 " "           |
| 170               | "                    | "        | 270                              | 6 B. 9 B. R.A. -                           |                                |                   |                  | Store.               |
| 171               | "                    | "        |                                  | 1 B. 4 " -                                 |                                |                   |                  | 4 B. 8 B. R.A.       |
| 172               | "                    | "        | 141                              | 3 B. 8 " -                                 |                                | 11 2 0            | 0 10 6           | Store.               |
| 173               | "                    | "        |                                  | B. B. R.H.A. -                             |                                |                   |                  | Shoeburyness.        |
| 174               | "                    | "        | 150                              | 4 B. 8 B. R.A. -                           |                                | 4 18 4            | 0 4 6            | A. B. 9 B. R.A.      |
| 175               | "                    | "        |                                  | Depôt, R.H.A. -                            |                                |                   |                  | Store.               |
| 176               | "                    | "        | 37                               | Shoeburyness -                             |                                |                   |                  | E. B. 4 B. R.A.      |
| 177               | "                    | "        |                                  | A. B. 9 B. R.A. -                          |                                |                   |                  | Shoeburyness.        |
| 178               | "                    | "        |                                  | H. " " -                                   | R                              | 6 2 0             | - - -            | K. B. 4 B. R.A.      |
| 179               | "                    | "        | 36                               | E. " 4 " -                                 |                                |                   |                  | A. " 9 " "           |
| 180               | "                    | "        |                                  | Shoeburyness -                             |                                |                   |                  | 3 " 8 " "            |
| 181               | "                    | "        | 710                              | K. B. 4 B. R.A. -                          |                                |                   |                  | Store.               |
| 182               | "                    | "        |                                  | A. " 9 " -                                 |                                |                   |                  | 5 B. 9 B. R.A.       |
| 183               | "                    | "        | 163                              | 3 " 8 " -                                  |                                |                   |                  | S.W. District.       |
| 184               | "                    | "        | 150                              | " " " -                                    |                                |                   |                  | 2 B. 8 B. R.A.       |
| 185               | "                    | "        | 26                               | 8 B. 9 " -                                 |                                | 6 2 0             | - - -            |                      |
| 186               | "                    | "        |                                  | 5 " " -                                    |                                |                   |                  |                      |
| 187               | "                    | "        | 200                              | S.W. District -                            |                                |                   |                  |                      |
| 188               | "                    | "        |                                  | 2 B. 8 B. R.A. -                           |                                |                   |                  |                      |
| 189               | "                    | "        | 42                               | " " " -                                    |                                |                   |                  |                      |
| 190               | "                    | "        |                                  | " " " -                                    |                                |                   |                  |                      |
| 191               | "                    | "        |                                  | " " " -                                    |                                |                   |                  |                      |
| 192               | "                    | "        |                                  | " " " -                                    |                                |                   |                  |                      |
| 193               | "                    | "        |                                  | " " " -                                    |                                |                   |                  |                      |
| 194               | "                    | "        |                                  | " " " -                                    |                                |                   |                  |                      |
| 195               | "                    | "        |                                  | " " " -                                    |                                |                   |                  |                      |
| 196               | "                    | "        |                                  | " " " -                                    |                                |                   |                  |                      |
| 197               | "                    | "        |                                  | " " " -                                    |                                |                   |                  |                      |
| 198               | "                    | "        |                                  | " " " -                                    |                                |                   |                  |                      |
| 199               | "                    | "        |                                  | " " " -                                    |                                |                   |                  |                      |
| 200               | "                    | "        |                                  | " " " -                                    |                                |                   |                  |                      |
| 201               | "                    | "        |                                  | " " " -                                    |                                |                   |                  |                      |
| 202               | "                    | "        |                                  | " " " -                                    |                                |                   |                  |                      |

## Return of Armstrong Guns issued—continued.

| No.<br>of<br>Gun. | Nature of Gun.       | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |          | Present Station. |
|-------------------|----------------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|----------|------------------|
|                   |                      |          |                                  |                                            |                                | Alteration. | Repair.  |                  |
|                   |                      |          |                                  |                                            |                                | £ s. d.     | £ s. d.  |                  |
| 203               | 12-pr. L.S.—8½ cwt.— | R. G. F. | 249                              | Shoeburyness                               | -                              |             |          | Shoeburyness.    |
| 206               | "                    | "        | "                                | Depôt, R.H.A.                              | -                              | 5 4 7       | 0 4 6    | Store.           |
| 208               | "                    | "        | 101                              | 6 B. 8 B. R.A.                             | -                              |             |          | 6 B. 8 B. R.A.   |
| 209               | "                    | "        | 140                              | 3 "                                        | -                              |             |          | 3 "              |
| 210               | "                    | "        | "                                | Calcutta "                                 | -                              |             |          | Calcutta.        |
| 211               | "                    | "        | 150                              | 4 B. 8 B. R.A.                             | -                              |             |          | 4 B. 8 B. R.A.   |
| 212               | "                    | "        | "                                | A. B. R.H.A.                               | -                              | 7 13 0      | 0 2 0    | Store.           |
| 215               | "                    | "        | "                                | Calcutta "                                 | -                              |             |          | Calcutta.        |
| 216               | "                    | "        | "                                | J. B. R.H.A.                               | -                              | 5 5 0       | 0 12 6   | B. B. 9 B. R.A.  |
| 217               | "                    | "        | 9                                | O. S. Committee                            | -                              | 9 14 3      | - - -    | Store.           |
| 220               | "                    | "        | "                                | J. B. 4 B. R.A.                            | -                              | 6 2 0       | - - -    | Do.              |
| 222               | "                    | "        | "                                | Fort Cumberland                            | -                              | 6 12 6      | 21 1 11½ | Do.              |
| 224               | "                    | "        | "                                | B. B. R.H.A.                               | -                              | 11 5 6      | 0 12 3   | Do.              |
| 226               | "                    | "        | 151                              | 4 B. 8 B. R.A.                             | -                              |             |          | 4 B. 8 B. R.A.   |
| 228               | "                    | "        | "                                | 8 " 4 "                                    | -                              |             |          | 8 B. 4 "         |
| 230               | "                    | "        | "                                | 1 " 4 "                                    | -                              |             |          | 1 " "            |
| 231               | "                    | "        | "                                | A. B. 8 B. "                               | -                              |             |          | A. B. 8 "        |
| 232               | "                    | "        | 50                               | 8 B. 4 "                                   | -                              |             |          | H. B. 9 "        |
| 233               | "                    | "        | "                                | " "                                        | -                              |             |          | 8 " 4 "          |
| 234               | "                    | "        | "                                | J. " "                                     | -                              |             |          | J. B. 4 "        |
| 235               | "                    | "        | 149                              | 4 B. 8 "                                   | -                              |             |          | 4 " 8 "          |
| 236               | "                    | "        | "                                | A. B. 9 "                                  | -                              |             |          | A. B. 9 "        |
| 240               | "                    | "        | "                                | Fort Cumberland                            | -                              | 9 7 3       | 0 5 6    | Store.           |
| 241               | "                    | "        | "                                | 8 B. 4 B. R.A.                             | -                              |             |          | 8 B. 4 B. R.A.   |
| 242               | "                    | "        | "                                | J. B. "                                    | -                              |             |          | J. " "           |
| 243               | "                    | "        | 237                              | Shoeburyness                               | -                              |             |          | Shoeburyness.    |
| 247               | "                    | "        | "                                | A. B. 8 B. R.A.                            | -                              |             |          | A. B. 8 B. R.A.  |
| 248               | "                    | "        | "                                | G. B. 4 "                                  | -                              |             |          | G. B. 4 "        |
| 249               | "                    | "        | 139                              | 3 B. 8 "                                   | -                              |             |          | 3 " 8 "          |
| 250               | "                    | "        | "                                | J. B. 4 "                                  | -                              | 6 2 0       | - - -    | Store.           |
| 252               | "                    | "        | 11 {                             | O. S. Committee                            | -                              | 9 9 3       | - - -    | Do.              |
| 253               | "                    | "        | "                                | Do. "                                      | -                              |             |          | Do.              |
| 254               | "                    | "        | "                                | G. B. 4 B. R.A.                            | -                              |             |          | G. B. 4 B. R.A.  |
| 256               | "                    | "        | 50                               | K. B. "                                    | -                              | 6 2 0       | - - -    | Store.           |
| 257               | "                    | "        | "                                | 4 B. 9 "                                   | -                              |             |          | 4 B. 9 B. R.A.   |
| 258               | "                    | "        | "                                | 2 B. 4 "                                   | -                              |             |          | 2 " 4 "          |
| 259               | "                    | "        | 200                              | B. B. R.H.A.                               | -                              | 11 1 3      | 0 11 3   | Store.           |
| 260               | "                    | "        | "                                | 5 B. 9 B. R.A.                             | -                              |             |          | 5 B. 9 B. R.A.   |
| 261               | "                    | "        | "                                | Fort Cumberland                            | -                              |             |          | Fort Cumberland. |
| 262               | "                    | "        | 100                              | O. S. Committee                            | -                              | 6 2 0       | - - -    | E. B. 4 B. R.A.  |
| 263               | "                    | "        | 100                              | 5 B. 9 B. R.A.                             | -                              |             |          | 5 " 9 "          |
| 264               | "                    | "        | 60                               | Shoeburyness                               | -                              | 9 16 0      | 0 8 0    | Store short.     |
| 265               | "                    | "        | "                                | A. B. 9 B. R.A.                            | -                              |             |          | A. B. 9 B. R.A.  |
| 266               | "                    | "        | "                                | J. B. 4 "                                  | -                              | 6 2 0       | - - -    | Store.           |
| 267               | "                    | "        | "                                | I. " "                                     | -                              |             |          | I. B. 4 B. R.A.  |
| 268               | "                    | "        | "                                | G. " "                                     | -                              |             |          | G. " "           |
| 269               | "                    | "        | 50                               | G. " 9 B. "                                | -                              |             |          | Store.           |
| 270               | "                    | "        | 189                              | 8 " " "                                    | -                              |             |          | Do.              |
| 272               | "                    | "        | "                                | Calcutta "                                 | -                              |             |          | Calcutta.        |
| 273               | "                    | "        | "                                | J. B. 4 B. R.A.                            | -                              | 6 2 0       | - - -    | Store.           |
| 274               | "                    | "        | "                                | 1 " "                                      | -                              |             |          | 1 B. 4 B. R.A.   |
| 277               | "                    | "        | 99                               | 6 B. 8 "                                   | -                              |             |          | 6 " 8 " "        |
| 278               | "                    | "        | 150                              | 7 " "                                      | -                              |             |          | 7 " " "          |
| 279               | "                    | "        | 50                               | 7 B. 9 B. "                                | -                              |             |          | 7 B. 9 B. "      |
| 280               | "                    | "        | 195                              | 8 " "                                      | -                              |             |          | Store.           |
| 281               | "                    | "        | 50                               | 4 " "                                      | -                              |             |          | 4 B. 9 B. R.A.   |
| 282               | "                    | "        | 1,176                            | Shoeburyness                               | -                              |             |          | Store.           |
| 283               | "                    | "        | "                                | 2 B. 4 B. R.A.                             | -                              |             |          | 2 B. 4 B. R.A.   |
| 284               | "                    | "        | 150                              | 7 B. 8 B. "                                | -                              |             |          | 7 B. 8 B. "      |
| 285               | "                    | "        | 50                               | G. B. 9 B. "                               | -                              |             |          | G. B. 9 B. "     |
| 286               | "                    | "        | 276                              | Shoeburyness                               | -                              |             |          | Shoeburyness.    |
| 287               | "                    | "        | 17                               | 8 B. 9 B. R.A.                             | -                              | 6 2 0       | - - -    | Store.           |
| 288               | "                    | "        | 150                              | 7 B. 8 B. "                                | -                              |             |          | 7 B. 8 B. R.A.   |
| 289               | "                    | "        | "                                | E. B. 4 B. "                               | -                              |             |          | E. B. 4 B. "     |
| 290               | "                    | "        | "                                | 1 B. " "                                   | -                              |             |          | 1 B. " "         |
| 291               | "                    | "        | "                                | K. B. " "                                  | -                              |             |          | K. B. " "        |
| 293               | "                    | "        | "                                | E. B. 4 B. R.A.                            | -                              |             |          | E. B. " "        |
| 294               | "                    | "        | 66                               | Shoeburyness                               | -                              | 9 14 6      | 0 4 6    | Store short.     |
| 295               | "                    | "        | 50                               | 7 B. 9 B. R.A.                             | -                              |             |          | 7 B. 9 B. R.A.   |
| 296               | "                    | "        | 60                               | Shoeburyness                               | -                              | 2 3 0       | 0 4 6    | Store short.     |
| 298               | "                    | "        | "                                | K. B. 4 B. R.A.                            | -                              |             |          | K. B. 4 B. R.A.  |
| 300               | "                    | "        | "                                | 8 B. " "                                   | -                              |             |          | 8 B. " "         |
| 301               | "                    | "        | 50                               | 4 B. 9 B. "                                | -                              |             |          | 4 B. 9 B. "      |
| 302               | "                    | "        | "                                | Calcutta "                                 | -                              |             |          | Calcutta.        |
| 303               | "                    | "        | 150                              | 4 B. 8 B. R.A.                             | -                              |             |          | 4 B. 8 B. R.A.   |
| 304               | "                    | "        | 120                              | 6 " 9 " "                                  | -                              |             |          | 6 " 9 " "        |
| 305               | "                    | "        | "                                | A. B. 8 B. "                               | -                              |             |          | A. B. 8 B. "     |
| 306               | "                    | "        | "                                | J. B. 4 " "                                | -                              | 6 2 0       | - - -    | Store.           |
| 307               | "                    | "        | 120                              | 6 B. 9 " "                                 | -                              |             |          | 6 B. 9 B. R.A.   |
| 308               | "                    | "        | "                                | G. B. 4 " "                                | -                              |             |          | G. B. 4 " "      |
| 310               | "                    | "        | 33                               | 2 B. 8 B. "                                | -                              |             |          | 2 B. 8 " "       |
| 311               | "                    | "        | 21                               | " " " "                                    | -                              |             |          | " " " "          |
| 312               | "                    | "        | "                                | B. B. R.H.A.                               | -                              | 11 4 0      | 0 11 0   | Store.           |
| 313               | "                    | "        | "                                | J. B. 4 B. R.A.                            | -                              |             |          | J. B. 4 B. R.A.  |
| 314               | "                    | "        | 120                              | 6 B. 9 " "                                 | -                              |             |          | 6 " 9 " "        |
| 315               | "                    | "        | 200                              | F. B. " "                                  | -                              |             |          | Store.           |
| 316               | "                    | "        | "                                | K. B. 4 B. "                               | -                              | 6 1 6       | - - -    | Do.              |



Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun.      | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.           |
|-------------------|---------------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|----------------------------|
|                   |                     |          |                                  |                                            |                                | Alteration. | Repair. |                            |
|                   |                     |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                            |
| 317               | 12-pr. L.S.—8½ cwt. | R. G. F. |                                  | A. B. 8 B. R.A.                            | -                              |             |         | A. B. 8 B. R.A.            |
| 318               | "                   | "        | 172                              | 6 B. 9 B.                                  | "                              |             |         | 6 B. 9 B.                  |
| 319               | "                   | "        | 50                               | 4 " "                                      | "                              |             |         | 4 " "                      |
| 320               | "                   | "        | "                                | Calcutta                                   | -                              |             |         | Calcutta.                  |
| 321               | "                   | "        | 66                               | Shoeburyness                               | -                              | 9 16 0      | 0 4 6   | Store short.               |
| 322               | "                   | "        | 50                               | 7 B. 9 B. R.A.                             | -                              |             |         | 7 B. 9 B. R.A.             |
| 323               | "                   | "        | 50                               | 4 B.                                       | "                              |             |         | 4 " "                      |
| 324               | "                   | "        | 1,145                            | Shoeburyness                               | -                              | 6 2 0       | 32 6 0  | Shoeburyness.              |
| 325               | "                   | "        | 150                              | 7 B. 8 B. R.A.                             | -                              |             |         | 7 B. 8 B. R.A.             |
| 327               | "                   | "        | "                                | 1 " 4 "                                    | "                              |             |         | 1 " 4 "                    |
| 328               | "                   | "        | "                                | A. " 8 "                                   | "                              |             |         | A. " 8 " cut short.        |
| 329               | "                   | "        | 31                               | Shoeburyness                               | -                              | 8 15 3      | - - -   | Store.                     |
| 330               | "                   | "        | 130                              | 3 B. 8 B. R.A.                             | -                              |             |         | 3 B. 8 B. R.A.             |
| 331               | "                   | "        | "                                | B. B. R.H.A.                               | -                              | 4 10 9      | 0 4 6   | Store.                     |
| 332               | "                   | "        | 173                              | 8 B. 9 B. R.A.                             | -                              | 6 2 0       | - - -   | Do.                        |
| 333               | "                   | "        | 50                               | 4 B.                                       | "                              |             |         | 4 B. 9 B. R.A.             |
| 334               | "                   | "        | "                                | J. B. R.H.A.                               | -                              | 3 9 3       | 0 10 3  | Store.                     |
| 335               | "                   | "        | 50                               | 7 B. 9 B. R.A.                             | -                              |             |         | 7 B. 9 B. R.A.             |
| 336               | "                   | "        | 100                              | 6 B. 8 B.                                  | "                              |             |         | 6 B. 8 B.                  |
| 337               | "                   | "        | 954                              | Shoeburyness                               | -                              | 6 2 0       | - - -   | Shoeburyness.              |
| 338               | "                   | "        | "                                | Do.                                        | -                              |             |         |                            |
| 339               | "                   | "        | 102                              | Fort Cumberland                            | -                              |             |         | Fort Cumberland.           |
| 340               | "                   | "        | 50                               | 6 B. 8 B. R.A.                             | -                              |             |         | 6 B. 8 B. R.A.             |
| 341               | "                   | "        | "                                | 7 " 9 " "                                  | -                              |             |         | 7 " 9 " "                  |
| 342               | "                   | "        | "                                | 5 " 8 " "                                  | -                              |             |         | O. S. Committee.           |
| 343               | "                   | "        | 50                               | Commandant                                 | -                              |             |         | Commandant.                |
| 344               | "                   | "        | "                                | 5 B. Dépôt -                               | -                              |             |         |                            |
| 345               | "                   | "        | 1,188                            | E. B. 8 B. R.A.                            | -                              |             |         | E. B. 8 B. R.A.            |
| 346               | "                   | "        | "                                | Shoeburyness                               | -                              |             |         | Shoeburyness.              |
| 347               | "                   | "        | 50                               | Commandant                                 | -                              |             |         | Commandant.                |
| 348               | "                   | "        | 50                               | 5 B. Dépôt -                               | -                              |             |         |                            |
| 349               | "                   | "        | 50                               | E. B. 8 B. R.A.                            | -                              |             |         | E. B. 8 B. R.A.            |
| 350               | "                   | "        | 100                              | 5 B. Dépôt -                               | -                              |             |         |                            |
| 351               | "                   | "        | 255                              | E. B. 8 B. R.A.                            | -                              |             |         | " " "                      |
| 352               | "                   | "        | "                                | 7 B. Dépôt -                               | -                              |             |         |                            |
| 353               | "                   | "        | 100                              | H. B. 8 B. R.A.                            | -                              | 1 10 6      | - - -   | H. B. 8 B. R.A.            |
| 354               | "                   | "        | 100                              | 7 B. Dépôt -                               | -                              |             |         |                            |
| 355               | "                   | "        | 100                              | H. B. 8 B. R.A.                            | -                              |             |         | " " "                      |
| 356               | "                   | "        | 50                               | 7 B. Dépôt -                               | -                              |             |         | " " "                      |
| 357               | "                   | "        | 50                               | H. B. 8 B. R.A.                            | -                              |             |         | E. B. " "                  |
| 358               | "                   | "        | 100                              | 5 B. Dépôt -                               | -                              | 4 8 9       | 0 4 6   | Store.                     |
| 359               | "                   | "        | 100                              | E. B. 8 B. R.A.                            | -                              |             |         | E. B. 8 B. R.A.            |
| 360               | "                   | "        | 100                              | 11th Dépôt -                               | -                              |             |         |                            |
| 361               | "                   | "        | 100                              | 5 B. " "                                   | -                              |             |         | H. B. " "                  |
| 362               | "                   | "        | 50                               | H. B. 8 B. R.A.                            | -                              |             |         | Store.                     |
| 363               | "                   | "        | 50                               | 7 B. " "                                   | -                              |             |         | H. B. 8 B. R.A.            |
| 364               | "                   | "        | 55                               | 11. B. 8 B. R.A.                           | -                              |             |         | E. B. " "                  |
|                   |                     |          |                                  | 5 B. Dépôt -                               | -                              |             |         |                            |
|                   |                     |          |                                  | E. B. 8 B. R.A.                            | -                              |             |         | Portsmouth, H.M.S.         |
|                   |                     |          |                                  | Portsmouth                                 | -                              |             |         | " Excellent " (cut short). |
|                   |                     |          |                                  | Devonport                                  | -                              |             |         | H.M.S. " Leopard,"         |
|                   |                     |          |                                  |                                            | -                              |             |         | S.S. (cut short).          |
| 1                 | 12-pr. S.S.—8 cwt.  | R. G. F. |                                  | Chatham                                    | -                              |             |         | Chatham.                   |
| 4                 | "                   | "        | "                                | Devonport                                  | -                              |             |         | Devonport.                 |
| 5                 | "                   | "        | "                                | Portsmouth                                 | -                              |             |         | Portsmouth.                |
| 7                 | "                   | "        | "                                | Devonport                                  | -                              |             |         | Devonport.                 |
| 8                 | "                   | "        | "                                | Chatham                                    | -                              |             |         | H.M.S. " Rattlesnake."     |
| 9                 | "                   | "        | "                                | Portsmouth                                 | -                              |             |         | Portsmouth.                |
| 12                | "                   | "        | "                                | Chatham                                    | -                              |             |         | Chatham.                   |
| 14                | "                   | "        | "                                | H.M.S. " Alecto "                          | -                              |             |         | H.M.S. " Alecto."          |
| 15                | "                   | "        | "                                | Portsmouth                                 | -                              |             |         | Portsmouth.                |
| 17                | "                   | "        | "                                | Chatham                                    | -                              |             |         | H.M.S. " Argus."           |
| 18                | "                   | "        | "                                | Devonport                                  | -                              |             |         | Devonport.                 |
| 19                | "                   | "        | "                                | Do.                                        | -                              |             |         | Do.                        |
| 20                | "                   | "        | "                                | Chatham                                    | -                              |             |         | H.M.S. " Racoon."          |
| 21                | "                   | "        | "                                | "                                          | -                              |             |         |                            |
| 24                | "                   | "        | "                                | Chatham                                    | -                              |             |         | H.M.S. " Defence."         |
| 25                | "                   | "        | "                                | Devonport                                  | -                              |             |         | " " Cambridge."            |
| 27                | "                   | "        | "                                | Chatham                                    | -                              |             |         | " " Racoon."               |
| 29                | "                   | "        | "                                | Portsmouth                                 | -                              |             |         | " " Excellent."            |
| 30                | "                   | "        | "                                | Devonport                                  | -                              |             |         | Devonport.                 |
| 31                | "                   | "        | "                                | Do.                                        | -                              |             |         | H.M.S. " Phoebe."          |
| 32                | "                   | "        | "                                | Chatham                                    | -                              |             |         | Chatham.                   |

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun.       | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.         |
|-------------------|----------------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|--------------------------|
|                   |                      |          |                                  |                                            |                                | Alteration. | Repair. |                          |
|                   |                      |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                          |
| 33                | 12-pr. S.S.—8 cwt. - | R. G. F. |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.              |
| 34                | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.               |
| 37                | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Barossa."        |
| 38                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | " "Conqueror."           |
| 39                | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.              |
| 40                | " " -                | "        | 26                               | Shoeburyness -                             | -                              |             |         | Shoeburyness.            |
| 41                | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Argus."          |
| 43                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Chatham.                 |
| 44                | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.               |
| 45                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Alert."          |
| 46                | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.              |
| 48                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                      |
| 50                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                      |
| 51                | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Argus."          |
| 52                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | " "Pylades."             |
| 53                | " " -                | "        |                                  | Devonport -                                | -                              |             |         | " "Valourous."           |
| 54                | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | " "Pylades."             |
| 56                | " " -                | "        | 45 {                             | Shoeburyness -                             | -                              |             |         | } Shoeburyness.          |
| 57                | " " -                | "        |                                  | Do. -                                      | -                              |             |         |                          |
| 58                | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                 |
| 59                | " " -                | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Cambridge."      |
| 60                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Devonport.               |
| 61                | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.              |
| 63                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                      |
| 64                | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                 |
| 65                | " " -                | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Valourous."      |
| 66                | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | " "Excellent."           |
| 67                | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.               |
| 70                | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Galatea."        |
| 71                | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.               |
| 72                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                      |
| 73                | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                 |
| 74                | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Excellent."      |
| 75                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | H.M.G.B. "Stork"         |
| 77                | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                 |
| 78                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Leander."        |
| 79                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Chatham.                 |
| 80                | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Do.                      |
| 82                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Buzzard."        |
| 87                | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | " "Euryalus."            |
| 88                | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Chatham.                 |
| 89                | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Portsmouth.              |
| 90                | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Devonport.               |
| 91                | " " -                | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Revenge."        |
| 92                | " " -                | "        |                                  | H.M.S. "Archer" -                          | -                              |             |         | " "Buzzard."             |
| 93                | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | " "Archer."              |
| 95                | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Portsmouth.              |
| 96                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Rattler."        |
| 97                | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Chatham.                 |
| 98                | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Devonport.               |
| 99                | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Valourous."      |
| 101               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | " "Mecanee."             |
| 102               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Portsmouth.              |
| 103               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Do.                      |
| 104               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Barossa."        |
| 105               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Chatham.                 |
| 106               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Portsmouth.              |
| 107               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Chatham.                 |
| 108               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Portsmouth.              |
| 111               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Devonport.               |
| 113               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Princess Royal." |
| 114               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Chatham.                 |
| 115               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Chatham.                 |
| 118               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Britannia."      |
| 119               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Devonport.               |
| 120               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Excellent."      |
| 121               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Portsmouth.              |
| 124               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Tribune."        |
| 125               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | " "Edgar."               |
| 126               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | " "Rattlesnake."         |
| 127               | " " -                | "        |                                  | Do. -                                      | -                              |             |         |                          |
| 128               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Portsmouth.              |
| 129               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Chatham.                 |
| 130               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         |                          |
| 131               | " " -                | "        |                                  |                                            | -                              |             |         | Devonport.               |
| 133               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Hannibal."       |
| 134               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.              |
| 135               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Devonport.               |
| 136               | " " -                | "        | 12                               | Devonport -                                | -                              |             |         | H.M.S. "Trafalgar."      |
| 138               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                 |
| 140               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Shannon."        |
| 141               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.              |
| 143               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Sutlej."         |
| 145               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | " "Cambridge."           |
| 146               | " " -                | "        |                                  | Devonport -                                | -                              |             |         |                          |



Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun.       | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.               |
|-------------------|----------------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|--------------------------------|
|                   |                      |          |                                  |                                            |                                | Alteration. | Repair. |                                |
|                   |                      |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                                |
| 147               | 12-pr. S.S.—8 cwt. - | R. G. F. |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Virago."               |
| 148               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | " "Emerald."                   |
| 149               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Portsmouth.                    |
| 150               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 152               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 153               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Virago."               |
| 154               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Portsmouth.                    |
| 155               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 157               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Excellent."            |
| 159               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | " "Tribune."                   |
| 160               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 161               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Sutlej."               |
| 162               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 163               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Virago."               |
| 164               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Portsmouth.                    |
| 166               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "St. Vincent."          |
| 168               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Portsmouth.                    |
| 169               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 170               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Cambridge."            |
| 172               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | "                              |
| 173               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | " "St. Vincent."               |
| 174               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 175               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                    |
| 176               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 177               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Liverpool."            |
| 179               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 180               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 181               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 182               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Duncan."               |
| 183               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 184               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                    |
| 186               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 187               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 188               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Cambridge."            |
| 191               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                    |
| 192               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 193               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 195               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 196               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                    |
| 197               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 198               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                    |
| 199               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 200               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Meeanee."              |
| 201               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                    |
| 202               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 204               | " " -                | "        |                                  | " " -                                      | -                              |             |         | " " -                          |
| 205               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 206               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 207               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                    |
| 209               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 211               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 212               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 213               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Frederick<br>William." |
| 214               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Portsmouth.                    |
| 216               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 217               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 219               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 220               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                    |
| 222               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 223               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 224               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                    |
| 225               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 226               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Liffey."               |
| 227               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 228               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 229               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                    |
| 230               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 233               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 234               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 236               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                    |
| 237               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 238               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 239               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 240               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 241               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 242               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 243               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                    |
| 244               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 245               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 246               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                    |
| 247               | " " -                | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                     |
| 248               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 249               | " " -                | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                    |
| 250               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |
| 251               | " " -                | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                       |
| 252               | " " -                | "        |                                  | Do. -                                      | -                              |             |         | Do.                            |

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun.       | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.            |
|-------------------|----------------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|-----------------------------|
|                   |                      |          |                                  |                                            |                                | Alteration. | Repair. |                             |
|                   |                      |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                             |
| 254               | 12-pr. S.S.—8 cwt. - | R. G. F. |                                  | Devonport - -                              |                                |             |         | Devonport.                  |
| 256               | " " -                | "        |                                  | Chatham - -                                |                                |             |         | Chatham.                    |
| 258               | " " -                | "        |                                  | Do. - -                                    |                                |             |         | Do.                         |
| 260               | " " -                | "        |                                  | Do. - -                                    |                                |             |         | Do.                         |
|                   |                      |          |                                  |                                            |                                |             |         |                             |
| 1                 | 20-pounder, S.S. -   | R. G. F. |                                  | Portsmouth - -                             |                                |             |         | H.M.G.V. "Cygnets."         |
| 2                 | " " -                | "        |                                  | Chatham - -                                |                                |             |         | " "Plover."                 |
| 3                 | " " -                | "        |                                  | Fort Cumberland                            |                                |             |         | Fort Cumberland.            |
| 4                 | " " -                | "        |                                  | H.M.S. "Excellent"                         |                                |             |         | H.M.S. "Excellent."         |
| 5                 | " " -                | "        |                                  | Chatham - -                                |                                |             |         | " "Griffin."                |
| 6                 | " " -                | "        |                                  | Do. - -                                    |                                |             |         | " "Swallow."                |
| 7                 | " " -                | "        |                                  | Devonport - -                              |                                |             |         | " "Alert."                  |
| 8                 | " " -                | "        |                                  | Do. - -                                    |                                |             |         | " "Gibraltar."              |
| 9                 | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | Portsmouth.                 |
| 10                | " " -                | "        |                                  | Chatham - -                                |                                |             |         | H.M.S. "Griffin."           |
| 11                | " " -                | "        |                                  | Devonport - -                              |                                |             |         | " "Orlando."                |
| 12                | " " -                | "        | 104                              | H.M.S. "Cambridge"                         |                                |             |         | " "Princess<br>Royal."      |
| 13                | " " -                | "        | 779                              | Shoeburyness - -                           |                                |             |         | } Shoeburyness.             |
| 14                | " " -                | "        |                                  | Do. - -                                    |                                |             |         | H.M.G.V. "Pandora."         |
| 15                | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | H.M.S. "Virago."            |
| 16                | " " -                | "        |                                  | Devonport - -                              |                                |             |         | H.M.G.V. "Penguin."         |
| 17                | " " -                | "        |                                  | Do. - -                                    |                                |             |         | " "Steady."                 |
| 18                | " " -                | "        |                                  | Do. - -                                    |                                |             |         | H.M.S. "Conqueror."         |
| 19                | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | Portsmouth.                 |
| 20                | " " -                | "        |                                  | H.M.S. "Warrior" -                         |                                |             |         | H.M.S. "Warrior."           |
| 21                | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | " "Edgar."                  |
| 22                | " " -                | "        |                                  | Devonport - -                              |                                |             |         | Devonport.                  |
| 23                | " " -                | "        | 117                              | H.M.S. "Cambridge"                         |                                |             |         | H.M.S. "Princess<br>Royal." |
| 24                | " " -                | "        |                                  | Chatham - -                                |                                |             |         | H.M.G.B. "Mullet."          |
| 25                | " " -                | "        |                                  | Do. - -                                    |                                |             |         | " "Plover."                 |
| 26                | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | " "Pandora."                |
| 27                | " " -                | "        |                                  | Chatham - -                                |                                |             |         | H.M.S. "Galatea."           |
| 28                | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | H.M.G.B. "Cygnets."         |
| 29                | " " -                | "        |                                  | H.M.S. "Narcissus"                         |                                |             |         | H.M.S. "Leander."           |
| 30                | " " -                | "        |                                  | Devonport - -                              |                                |             |         | H.M.G.B. "Penguin."         |
| 31                | " " -                | "        |                                  | H.M.S. "Excellent"                         |                                |             |         | H.M.S. "Excellent."         |
| 32                | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | Portsmouth.                 |
| 33                | " " -                | "        |                                  | Chatham - -                                |                                |             |         | H.M.G.B. "Mullet."          |
| 34                | " " -                | "        |                                  | Devonport - -                              |                                |             |         | H.M.S. "Icarus."            |
| 35                | " " -                | "        |                                  | Do. - -                                    |                                |             |         |                             |
| 36                | " " -                | "        |                                  | Do. - -                                    |                                |             |         | H.M.G.V. "Nimble."          |
| 37                | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | Portsmouth.                 |
| 38                | " " -                | "        |                                  | Devonport - -                              |                                |             |         | H.M.S. "Alert."             |
| 39                | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | " "Victory."                |
| 40                | " " -                | "        |                                  | Chatham - -                                |                                |             |         | " "Defence."                |
| 41                | " " -                | "        |                                  | H.M.S. "Narcissus"                         |                                |             |         | " "Narcissus."              |
| 42                | " " -                | "        |                                  | Devonport - -                              |                                |             |         | H.M.G.B. "Nimble."          |
| 43                | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | H.M.S. "Victory."           |
| 44                | " " -                | "        |                                  | Devonport - -                              |                                |             |         | " "Aboukir."                |
| 45                | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | Portsmouth.                 |
| 46                | " " -                | "        |                                  | Chatham - -                                |                                |             |         | H.M.S. "Swallow."           |
| 48                | " " -                | "        |                                  | Devonport - -                              |                                |             |         | " "Icarus."                 |
| 49                | " " -                | "        |                                  | Do. - -                                    |                                |             |         | Do.                         |
| 50                | " " -                | "        |                                  | Chatham - -                                |                                |             |         | H.M.G.B. "Lee."             |
| 51                | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | H.M.S. "Medea."             |
| 52                | " " -                | "        |                                  | Do. - -                                    |                                |             |         | " "Marlborough."            |
| 53                | " " -                | "        |                                  | Do. - -                                    |                                |             |         | Do.                         |
| 54                | " " -                | "        |                                  | H.M.S. "Archer"                            |                                |             |         | H.M.S. "Archer."            |
| 55                | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | Portsmouth.                 |
| 56                | " " -                | "        |                                  | Chatham - -                                |                                |             |         | H.M.S. "Jaseur."            |
| 57                | " " -                | "        |                                  | H.M.S. "Archer"                            |                                |             |         | " "Archer."                 |
| 58                | " " -                | "        |                                  | Devonport - -                              |                                |             |         | Devonport.                  |
| 59                | " " -                | "        |                                  | Chatham - -                                |                                |             |         | H.M.S. "Leander."           |
| 60                | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | Portsmouth.                 |
| 61                | " " -                | "        |                                  | Devonport - -                              |                                |             |         | H.M.S. "Liverpool."         |
| 62                | " " -                | "        |                                  | Do. - -                                    |                                |             |         | Devonport.                  |
| 63                | " " -                | "        |                                  | Do. - -                                    |                                |             |         | Do.                         |
| 64                | " " -                | "        |                                  | Chatham - -                                |                                |             |         | H.M.S. "Resistance."        |
| 65                | " " -                | "        |                                  | Devonport - -                              |                                |             |         | " "Gibraltar."              |
| 66                | " " -                | "        |                                  | Chatham - -                                |                                |             |         | " "Trafalgar."              |
| 67                | " " -                | "        |                                  | Do. - -                                    |                                |             |         | Chatham.                    |
| 68                | " " -                | "        |                                  | H.M.S. "Rapid"                             |                                |             |         | H.M.S. "Rapid."             |
| 69                | " " -                | "        |                                  | Devonport - -                              |                                |             |         | " "Petrel."                 |
| 70                | " " -                | "        |                                  | Do. - -                                    |                                |             |         | " "Liverpool."              |
| 71                | " " -                | "        |                                  | Portsmouth - -                             |                                |             |         | " "Emerald."                |
| 72                | " " -                | "        |                                  | Chatham - -                                |                                |             |         | " "Barossa."                |
| 73                | " " -                | "        |                                  | Devonport - -                              |                                |             |         | Devonport.                  |
| 74                | " " -                | "        |                                  | Do. - -                                    |                                |             |         | Do.                         |
| 75                | " " -                | "        |                                  | Do. - -                                    |                                |             |         | Do.                         |



Return of Armstrong Guns issued—*continued*.

| No.<br>of<br>Gun. | Nature of Gun.   | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.       |
|-------------------|------------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|------------------------|
|                   |                  |          |                                  |                                            |                                | Alteration. | Repair. |                        |
|                   |                  |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                        |
| 76                | 20-pounder, S.S. | R. G. F. |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 77                | "                | "        |                                  | H.M.S. "Malacca" -                         |                                |             |         | H.M.S. "Malacca."      |
| 78                | "                | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 79                | "                | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Shannon."      |
| 80                | "                | "        |                                  | Do. -                                      |                                |             |         | Portsmouth.            |
| 81                | "                | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 82                | "                | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Alert."        |
| 83                | "                | "        |                                  | Do. -                                      |                                |             |         | Devonport.             |
| 84                | "                | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 85                | "                | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Barossa."      |
| 86                | "                | "        |                                  | Do. -                                      |                                |             |         | " "Rosario."           |
| 87                | "                | "        |                                  | Do. -                                      |                                |             |         | Chatham.               |
| 88                | "                | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Petrel."       |
| 89                | "                | "        |                                  | Chatham -                                  |                                |             |         | " "Jaseur."            |
| 90                | "                | "        |                                  | H.M.S. "Rapid" -                           |                                |             |         | " "Rapid."             |
| 91                | "                | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 92                | "                | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Severn."       |
| 93                | "                | "        |                                  | Do. -                                      |                                |             |         | Devonport.             |
| 94                | "                | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 95                | "                | "        |                                  | H.M.S. "Fisgard" -                         |                                |             |         | H.M.S. "Fisgard."      |
| 96                | "                | "        |                                  | Devonport -                                |                                |             |         | " "Euryalus."          |
| 97                | "                | "        |                                  | Do. -                                      |                                |             |         | Devonport.             |
| 98                | "                | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Rosario."      |
| 99                | "                | "        |                                  | Do. -                                      |                                |             |         | Chatham.               |
| 100               | "                | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 101               | "                | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Boscawen."     |
| 102               | "                | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 103               | "                | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 104               | "                | "        |                                  | Portsmouth -                               |                                |             |         | H.M.G.B. "Dart."       |
| 105               | "                | "        |                                  | Do. -                                      |                                |             |         | Portsmouth.            |
| 106               | "                | "        |                                  | Do. -                                      |                                |             |         | H.M.G.B. "Dart."       |
| 107               | "                | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Stromboli."    |
| 108               | "                | "        |                                  | Do. -                                      |                                |             |         | " "Duncan."            |
| 109               | "                | "        |                                  | Do. -                                      |                                |             |         | " "Trafalgar."         |
| 110               | "                | "        |                                  | Do. -                                      |                                |             |         | Portsmouth.            |
| 111               | "                | "        |                                  | Do. -                                      |                                |             |         | Store.                 |
| 112               | "                | "        |                                  | H.M.S. "Devastation" -                     |                                |             |         | H.M.S. "Duncan."       |
| 113               | "                | "        |                                  | Chatham -                                  |                                |             |         | " "Devastation."       |
| 114               | "                | "        |                                  | Portsmouth -                               |                                |             |         | " "Resistance."        |
| 115               | "                | "        |                                  | Laboratory -                               |                                |             |         | " "Barossa."           |
| 116               | "                | "        |                                  | H.M.S. "Rapid" -                           |                                |             |         | Store.                 |
| 117               | "                | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Rapid."        |
| 118               | "                | "        | 6                                | Do. -                                      |                                |             |         | " "Emerald."           |
| 119               | "                | "        |                                  | Chatham -                                  |                                |             |         | " "Conqueror."         |
| 120               | "                | "        |                                  | Devonport -                                |                                |             |         | Chatham.               |
| 121               | "                | "        | 25                               | Portsmouth -                               |                                |             |         | H.M.S. "Liffey."       |
| 122               | "                | "        |                                  | Devonport -                                |                                |             |         | Portsmouth.            |
| 123               | "                | "        |                                  | Chatham -                                  |                                |             |         | Devonport.             |
| 124               | "                | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Wellesley."    |
| 125               | "                | "        |                                  | Devonport -                                |                                |             |         | Do.                    |
| 126               | "                | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Sparrow."      |
| 127               | "                | "        |                                  | Do. -                                      |                                |             |         | " "Leopard."           |
| 128               | "                | "        |                                  | Do. -                                      |                                |             |         | " "Impregnable."       |
| 129               | "                | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 130               | "                | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 131               | "                | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Black Prince." |
| 132               | "                | "        |                                  | Do. -                                      |                                |             |         | Portsmouth.            |
| 133               | "                | "        | 64                               | Devonport -                                |                                |             |         | Devonport.             |
| 134               | "                | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Meeanee."      |
| 135               | "                | "        |                                  | Do. -                                      |                                |             |         | H.M.G.B. "Lee."        |
| 136               | "                | "        |                                  | H.M.S. "Fisgard" -                         |                                |             |         | H.M.S. "Fisgard."      |
| 137               | "                | "        |                                  | Devonport -                                |                                |             |         | " "Leopard."           |
| 138               | "                | "        |                                  | Do. -                                      |                                |             |         | " "Sparrow."           |
| 139               | "                | "        |                                  | Do. -                                      |                                |             |         | " "Styx."              |
| 140               | "                | "        |                                  | Chatham -                                  |                                |             |         | " "Rosario."           |
| 141               | "                | "        |                                  | Portsmouth -                               |                                |             |         | " "Bik. Prince."       |
| 142               | "                | "        |                                  | Devonport -                                |                                |             |         | " "Petrel."            |
| 143               | "                | "        |                                  | Portsmouth -                               |                                |             |         | " "Sutlej."            |
| 144               | "                | "        |                                  | H.M.S. "Vesuvius" -                        |                                |             |         | " "Vesuvius."          |
| 145               | "                | "        |                                  | Portsmouth -                               |                                |             |         | " "Edgar."             |
| 146               | "                | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 147               | "                | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 148               | "                | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Pantaloons."   |
| 149               | "                | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 150               | "                | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Shannon."      |
| 151               | "                | "        |                                  | H.M.S. "Rapid" -                           |                                |             |         | " "Rapid."             |
| 152               | "                | "        |                                  | Portsmouth -                               |                                |             |         | " "Revenge."           |
| 153               | "                | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 154               | "                | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Conqueror."    |
| 155               | "                | "        |                                  | Do. -                                      |                                |             |         | " "Rosario."           |
| 156               | "                | "        |                                  | Do. -                                      |                                |             |         | Chatham.               |
| 157               | "                | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Euryalus."     |
| 158               | "                | "        |                                  | Portsmouth -                               |                                |             |         | " "Sutlej."            |
| 159               | "                | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 160               | "                | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Phoebe."       |
| 161               | "                | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 162               | "                | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 163               | "                | "        |                                  |                                            |                                |             |         |                        |
| 164               | "                | "        |                                  |                                            |                                |             |         |                        |

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun.   | Maker. | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.               |
|-------------------|------------------|--------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|--------------------------------|
|                   |                  |        |                                  |                                            |                                | Alteration. | Repair. |                                |
|                   |                  |        |                                  |                                            |                                | £ s. d.     | £ s. d. |                                |
| 165               | 20-pounder, S.S. | -      |                                  | Chatham                                    | -                              |             |         | Chatham.                       |
| 166               | "                | "      |                                  | Devonport                                  | -                              |             |         | H.M.S. "Phoebe."               |
| 167               | "                | "      |                                  | Do.                                        | -                              |             |         | " "Severn."                    |
| 168               | "                | "      |                                  | Do.                                        | -                              |             |         | Devonport.                     |
| 169               | "                | "      |                                  | Do.                                        | -                              |             |         | Do.                            |
| 170               | "                | "      |                                  | Do.                                        | -                              |             |         | H.M.S. "Pantaloons."           |
| 171               | "                | "      |                                  | Chatham                                    | -                              |             |         | Chatham.                       |
| 172               | "                | "      |                                  | Devonport                                  | -                              |             |         | H.M.S. "Alert."                |
| 173               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | Portsmouth.                    |
| 174               | "                | "      |                                  | H.M.S. "Malacca"                           | -                              |             |         | H.M.S. "Malacca."              |
| 175               | "                | "      |                                  | Chatham                                    | -                              |             |         | Chatham.                       |
| 176               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | H.M.S. "Revenge."              |
| 177               | "                | "      |                                  | Devonport                                  | -                              |             |         | " "Impregnable."               |
| 178               | "                | "      |                                  | Do.                                        | -                              |             |         | " "Pantaloons."                |
| 179               | "                | "      |                                  | Do.                                        | -                              |             |         | Devonport.                     |
| 180               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | Portsmouth.                    |
| 181               | "                | "      |                                  | Do.                                        | -                              |             |         | H.M.S. "Galatea."              |
| 182               | "                | "      |                                  | Do.                                        | -                              |             |         | " "Frederick<br>William."      |
| 183               | "                | "      |                                  | Chatham                                    | -                              |             |         | Chatham.                       |
| 184               | "                | "      |                                  | Do.                                        | -                              |             |         | Do.                            |
| 185               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | Portsmouth.                    |
| 186               | "                | "      |                                  | Chatham                                    | -                              |             |         | Chatham.                       |
| 187               | "                | "      |                                  | Do.                                        | -                              |             |         | Do.                            |
| 188               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | Portsmouth.                    |
| 189               | "                | "      |                                  | Devonport                                  | -                              |             |         | H.M.S. "Petrel."               |
| 190               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | " "Warrior."                   |
| 191               | "                | "      |                                  | Devonport                                  | -                              |             |         | Devonport.                     |
| 192               | "                | "      |                                  | Shoeburyness                               | -                              |             |         | Shoeburyness.                  |
| 193               | "                | "      |                                  | Devonport                                  | -                              |             |         | Devonport.                     |
| 194               | "                | "      |                                  | Do.                                        | -                              |             |         | Do.                            |
| 195               | "                | "      |                                  | Do.                                        | -                              |             |         | Do.                            |
| 196               | "                | "      |                                  | Chatham                                    | -                              |             |         | H.M.S. "Barossa."              |
| 198               | "                | "      |                                  | Do.                                        | -                              |             |         | Chatham.                       |
| 200               | "                | "      |                                  | Devonport                                  | -                              |             |         | H.M.S. "Liffey."               |
| 202               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | Portsmouth.                    |
| 203               | "                | "      |                                  | Do.                                        | -                              |             |         | Store.                         |
| 204               | "                | "      |                                  | Devonport                                  | -                              |             |         | Devonport.                     |
| 207               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | Portsmouth.                    |
| 208               | "                | "      |                                  | H.M.S. "Archer"                            | -                              |             |         | H.M.S. "Archer."               |
| 209               | "                | "      |                                  | Devonport                                  | -                              |             |         | Devonport.                     |
| 210               | "                | "      |                                  | Do.                                        | -                              |             |         | Do.                            |
| 211               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | Portsmouth.                    |
| 212               | "                | "      |                                  | Devonport                                  | -                              |             |         | Devonport.                     |
| 213               | "                | "      |                                  | Chatham                                    | -                              |             |         | Chatham.                       |
| 214               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | Portsmouth.                    |
| 216               | "                | "      |                                  | Devonport                                  | -                              |             |         | H.M.S. "Pantaloons."           |
| 217               | "                | "      |                                  | Do.                                        | -                              |             |         | Devonport.                     |
| 218               | "                | "      |                                  | Chatham                                    | -                              |             |         | Chatham.                       |
| 219               | "                | "      |                                  | Do.                                        | -                              |             |         | Do.                            |
| 220               | "                | "      |                                  | Devonport                                  | -                              |             |         | Devonport.                     |
| 221               | "                | "      |                                  | H.M.S. "Archer"                            | -                              |             |         | H.M.S. "Archer."               |
| 222               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | Portsmouth.                    |
| 224               | "                | "      |                                  | Do.                                        | -                              |             |         | H.M.S. "Boscawen."             |
| 225               | "                | "      |                                  | H.M.S. "Malacca"                           | -                              |             |         | " "Malacca."                   |
| 226               | "                | "      |                                  | Devonport                                  | -                              |             |         | Devonport.                     |
| 227               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | H.M.S. "Frederick<br>William." |
| 228               | "                | "      |                                  | Do.                                        | -                              |             |         | Portsmouth.                    |
| 229               | "                | "      |                                  | Do.                                        | -                              |             |         | Do.                            |
| 230               | "                | "      |                                  | Devonport                                  | -                              |             |         | Devonport.                     |
| 232               | "                | "      |                                  | Do.                                        | -                              |             |         | Do.                            |
| 233               | "                | "      | 5                                | H.M.S. "Malacca"                           | -                              |             |         | H.M.S. "Malacca."              |
| 234               | "                | "      |                                  | Devonport                                  | -                              |             |         | Devonport.                     |
| 235               | "                | "      |                                  | Do.                                        | -                              |             |         | Do.                            |
| 236               | "                | "      |                                  | Do.                                        | -                              |             |         | Do.                            |
| 237               | "                | "      | 12                               | Portsmouth                                 | -                              |             |         | Portsmouth.                    |
| 238               | "                | "      |                                  | Devonport                                  | -                              |             |         | Devonport.                     |
| 239               | "                | "      |                                  | H.M.S. "Malacca"                           | -                              |             |         | H.M.S. "Malacca."              |
| 241               | "                | "      |                                  | Devonport                                  | -                              |             |         | Devonport.                     |
| 242               | "                | "      |                                  | H.M.S. "Alecto"                            | -                              |             |         | H.M.S. "Alecto."               |
| 243               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | Portsmouth.                    |
| 245               | "                | "      |                                  | H.M.S. "Alecto"                            | -                              |             |         | H.M.S. "Alecto."               |
| 246               | "                | "      | 25                               | Portsmouth                                 | -                              |             |         | Portsmouth.                    |
| 248               | "                | "      |                                  | Devonport                                  | -                              |             |         | Devonport.                     |
| 249               | "                | "      |                                  | Chatham                                    | -                              |             |         | H.M.G.B. "Snipe."              |
| 250               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | Portsmouth.                    |
| 251               | "                | "      |                                  | Devonport                                  | -                              |             |         | Devonport.                     |
| 252               | "                | "      |                                  | Do.                                        | -                              |             |         | Do.                            |
| 253               | "                | "      |                                  | Portsmouth                                 | -                              |             |         | Portsmouth.                    |
| 254               | "                | "      |                                  | Devonport                                  | -                              |             |         | Devonport.                     |
| 255               | "                | "      |                                  | Do.                                        | -                              |             |         | Do.                            |



Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun.    | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.                                    |
|-------------------|-------------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|-----------------------------------------------------|
|                   |                   |          |                                  |                                            |                                | Alteration. | Repair. |                                                     |
|                   |                   |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                                                     |
| 2                 | 20-pounder, L.S.  | R. G. F. | 483                              | Shoeburyness                               | R                              |             |         | Store.                                              |
| 10                | "                 | "        |                                  | Commandant                                 |                                |             |         | Commandant.                                         |
| 14                | "                 | "        |                                  | O. S. Committee                            |                                |             |         | Store.                                              |
| 21                | "                 | "        |                                  | Canada                                     |                                |             |         | Canada.                                             |
| 23                | "                 | "        |                                  | Commandant                                 |                                |             |         | Commandant.                                         |
| 24                | "                 | "        | 10                               | Shoeburyness                               |                                |             |         | Shoeburyness.                                       |
| 26                | "                 | "        | 19                               | Do.                                        |                                |             |         | Store.                                              |
| 27                | "                 | "        |                                  | Canada                                     |                                |             |         | Canada.                                             |
| 31                | "                 | "        |                                  | Shoeburyness                               |                                |             |         | Shoeburyness.                                       |
| 33                | "                 | "        |                                  | Canada                                     |                                |             |         | Canada.                                             |
| 36                | "                 | "        | 285                              | Shoeburyness                               |                                |             |         | Shoeburyness.                                       |
|                   |                   |          |                                  | Do.                                        |                                |             |         |                                                     |
|                   |                   |          |                                  | Do.                                        |                                |             |         |                                                     |
| 40                | "                 | "        | 376                              | Do.                                        |                                |             |         | Fort Cumberland.<br>Shoeburyness.<br>Canada.<br>Do. |
| 44                | "                 | "        |                                  | Fort Cumberland                            |                                |             |         |                                                     |
| 46                | "                 | "        | 34                               | Shoeburyness                               |                                |             |         |                                                     |
| 48                | "                 | "        |                                  | Canada                                     |                                |             |         |                                                     |
| 49                | "                 | "        |                                  | Do.                                        |                                |             |         |                                                     |
| 51                | "                 | "        |                                  |                                            |                                |             |         |                                                     |
| 55                | "                 | "        |                                  |                                            |                                |             |         |                                                     |
| 62                | "                 | "        |                                  | Canada                                     |                                |             |         | Canada.                                             |
|                   |                   |          |                                  |                                            |                                |             |         |                                                     |
| 1                 | 40-pounder, Long. | R. G. F. |                                  | Malta                                      |                                |             |         | Malta.                                              |
| 2                 | "                 | "        |                                  | Do.                                        |                                |             |         | Do.                                                 |
| 3                 | "                 | "        |                                  | Devonport                                  |                                |             |         | Devonport.                                          |
| 4                 | "                 | "        |                                  | Portsmouth                                 |                                |             |         | Portsmouth.                                         |
| 6                 | "                 | "        |                                  | Malta                                      |                                |             |         | Malta.                                              |
| 7                 | "                 | "        |                                  | Do.                                        |                                |             |         | Do.                                                 |
| 8                 | "                 | "        |                                  | Fort Cumberland                            |                                |             |         | Fort Cumberland.                                    |
| 9                 | "                 | "        |                                  | No. 18 Battery                             |                                |             |         | No. 18 Battery.                                     |
| 10                | "                 | "        |                                  | Fort Cumberland                            |                                |             |         | Fort Cumberland.                                    |
| 12                | "                 | "        |                                  | Halifax                                    |                                |             |         | Halifax.                                            |
| 13                | "                 | "        |                                  | Devonport                                  |                                |             |         | Devonport.                                          |
| 15                | "                 | "        |                                  | Do.                                        |                                |             |         | Do.                                                 |
| 16                | "                 | "        |                                  | Malta                                      |                                |             |         | Malta.                                              |
| 17                | "                 | "        |                                  | Portsmouth                                 |                                |             |         | Portsmouth.                                         |
| 18                | "                 | "        |                                  | Do.                                        |                                |             |         | H.M.S. "Frederick<br>William."                      |
| 19                | "                 | "        |                                  | Portsmouth                                 |                                |             |         | Do.                                                 |
| 20                | "                 | "        |                                  | Malta                                      |                                |             |         | Malta.                                              |
| 21                | "                 | "        |                                  | No. 17 Battery                             |                                |             |         | No. 17 Battery.                                     |
| 22                | "                 | "        |                                  | Malta                                      |                                |             |         | Malta.                                              |
| 23                | "                 | "        |                                  | Portsmouth                                 |                                |             |         | H.M.S. "Frederick<br>William."                      |
| 24                | "                 | "        |                                  | Devonport                                  |                                |             |         | Devonport.                                          |
| 25                | "                 | "        |                                  | Do.                                        |                                |             |         | Do.                                                 |
| 26                | "                 | "        |                                  | Portsmouth                                 |                                |             |         | Portsmouth.                                         |
| 27                | "                 | "        |                                  | Malta                                      |                                |             |         | Malta.                                              |
| 28                | "                 | "        |                                  | Devonport                                  |                                |             |         | Devonport.                                          |
| 29                | "                 | "        |                                  | Portsmouth                                 |                                |             |         | Portsmouth.                                         |
| 30                | "                 | "        |                                  | Malta                                      |                                |             |         | Malta.                                              |
| 31                | "                 | "        |                                  | Portsmouth                                 |                                |             |         | Portsmouth.                                         |
| 32                | "                 | "        |                                  | No. 21 Battery                             |                                |             |         | No. 21 Battery.                                     |
| 33                | "                 | "        |                                  | Portsmouth                                 |                                |             |         | H.M.S. "Frederick<br>William."                      |
| 34                | "                 | "        |                                  | Valparaiso                                 |                                |             |         | Valparaiso.                                         |
| 35                | "                 | "        |                                  | Malta                                      |                                |             |         | Malta.                                              |
| 36                | "                 | "        |                                  | Devonport                                  |                                |             |         | Devonport.                                          |
| 37                | "                 | "        |                                  | No. 18 Battery                             |                                |             |         | No. 18 Battery.                                     |
| 38                | "                 | "        |                                  | Devonport                                  |                                |             |         | Devonport.                                          |
| 39                | "                 | "        |                                  | Do.                                        |                                |             |         | Do.                                                 |
| 40                | "                 | "        |                                  | Valparaiso                                 |                                |             |         | Valparaiso.                                         |
| 41                | "                 | "        |                                  | Do.                                        |                                |             |         | Do.                                                 |
| 42                | "                 | "        |                                  | Do.                                        |                                |             |         | Do.                                                 |
| 43                | "                 | "        |                                  | Devonport                                  |                                |             |         | Devonport.                                          |
| 44                | "                 | "        |                                  | Valparaiso                                 |                                |             |         | Valparaiso.                                         |
| 45                | "                 | "        |                                  | Do.                                        |                                |             |         | Do.                                                 |
| 47                | "                 | "        |                                  | Do.                                        |                                |             |         | Do.                                                 |
| 48                | "                 | "        |                                  | Devonport                                  |                                |             |         | Devonport.                                          |
| 49                | "                 | "        |                                  | Rio de Janeiro                             |                                |             |         | Rio de Janeiro.                                     |
| 50                | "                 | "        |                                  | Do.                                        |                                |             |         | Do.                                                 |
| 51                | "                 | "        |                                  | Devonport                                  |                                |             |         | Devonport.                                          |
| 52                | "                 | "        |                                  | No. 21 Battery                             |                                |             |         | No. 21 Battery.                                     |
| 53                | "                 | "        |                                  | Portsmouth                                 |                                |             |         | Portsmouth.                                         |
| 54                | "                 | "        |                                  | Devonport                                  |                                |             |         | H.M.S. "Triton."                                    |
| 55                | "                 | "        |                                  | Rio de Janeiro                             |                                |             |         | Rio de Janeiro.                                     |
| 56                | "                 | "        |                                  | Devonport                                  |                                |             |         | Devonport.                                          |
| 57                | "                 | "        |                                  | Do.                                        |                                |             |         | Do.                                                 |
| 58                | "                 | "        |                                  | Do.                                        |                                |             |         | Do.                                                 |
| 59                | "                 | "        |                                  | Rio de Janeiro                             |                                |             |         | Rio de Janeiro.                                     |
| 60                | "                 | "        |                                  | Devonport                                  |                                |             |         | Devonport.                                          |
| 61                | "                 | "        |                                  | No. 25 Battery                             |                                |             |         | No. 25 Battery.                                     |
| 62                | "                 | "        |                                  | Devonport                                  |                                |             |         | Devonport.                                          |
| 63                | "                 | "        |                                  | No. 18 Battery                             |                                |             |         | No. 18 Battery.                                     |

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun.    | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.               |
|-------------------|-------------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|--------------------------------|
|                   |                   |          |                                  |                                            |                                | Alteration. | Repair. |                                |
|                   |                   |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                                |
| 64                | 40-pounder, Long. | R. G. F. |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 65                | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 66                | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 67                | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 68                | " "               | "        |                                  | No. 20 Battery                             |                                |             |         | No. 20 Battery.                |
| 69                | " "               | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.                    |
| 70                | " "               | "        |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 71                | " "               | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Frederick<br>William." |
| 72                | " "               | "        |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 73                | " "               | "        |                                  | No. 16 Battery                             |                                |             |         | No. 16 Battery.                |
| 74                | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 76                | " "               | "        |                                  | Rio de Janeiro                             |                                |             |         | Rio de Janeiro.                |
| 77                | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 78                | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 79                | " "               | "        |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 80                | " "               | "        |                                  | No. 17 Battery                             |                                |             |         | No. 17 Battery.                |
| 81                | " "               | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.                    |
| 82                | " "               | "        |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 83                | " "               | "        |                                  | No. 21 Battery                             |                                |             |         | No. 21 Battery.                |
| 84                | " "               | "        |                                  | No. 16 "                                   |                                |             |         | No. 16 "                       |
| 85                | " "               | "        |                                  | Rio de Janeiro                             |                                |             |         | Rio de Janeiro.                |
| 87                | " "               | "        |                                  | 16 Battery, R.A.                           |                                |             |         | 16 Battery, R.A.               |
| 88                | " "               | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.                    |
| 90                | " "               | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Frederick<br>William." |
| 91                | " "               | "        |                                  | 17 Battery, R.A.                           |                                |             |         | 17 Battery, R.A.               |
| 92                | " "               | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.                    |
| 93                | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 94                | " "               | "        |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 95                | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 96                | " "               | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Esk."                  |
| 97                | " "               | "        |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 98                | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 99                | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 100               | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 101               | " "               | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Frederick<br>William." |
| 102               | " "               | "        |                                  | Do. -                                      |                                |             |         | Portsmouth.                    |
| 103               | " "               | "        |                                  | 17 Battery, R.A.                           |                                |             |         | 17 Battery, R.A.               |
| 104               | " "               | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Frederick<br>William." |
| 108               | " "               | "        |                                  | 18 Battery, R.A.                           |                                |             |         | 18 Battery, R.A.               |
| 109               | " "               | "        |                                  | Portsmouth -                               |                                |             |         | H.M.G.B. "Pheasant."           |
| 111               | " "               | "        |                                  | Do. -                                      |                                |             |         | Portsmouth.                    |
| 112               | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 113               | " "               | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Frederick<br>William." |
| 114               | " "               | "        |                                  | Do. -                                      |                                |             |         | Portsmouth.                    |
| 115               | " "               | "        |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 116               | " "               | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Frederick<br>William." |
| 117               | " "               | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Valourous."            |
| 118               | " "               | "        |                                  | H.M.S. "Orontes"                           |                                |             |         | " "Orontes."                   |
| 119               | " "               | "        |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 120               | " "               | "        |                                  | Sydney -                                   |                                |             |         | Sydney.                        |
| 121               | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 122               | " "               | "        |                                  | Portsmouth -                               |                                |             |         | H.M.G.B. "Tyrian."             |
| 125               | " "               | "        |                                  | 20 Battery, R.A.                           |                                |             |         | 20 Battery, R.A.               |
| 126               | " "               | "        |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 127               | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 128               | " "               | "        |                                  | 19 Battery, R.A.                           |                                |             |         | 19 Battery, R.A.               |
| 129               | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 130               | " "               | "        |                                  | 21 Battery -                               |                                |             |         | 21 Battery.                    |
| 132               | " "               | "        |                                  | Sydney -                                   |                                |             |         | Sydney.                        |
| 133               | " "               | "        |                                  | 19 Battery, R.A.                           |                                |             |         | 19 Battery, R.A.               |
| 134               | " "               | "        |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 135               | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 136               | " "               | "        |                                  | H.M.S. "Alecto"                            |                                |             |         | H.M.S. "Alecto."               |
| 137               | " "               | "        |                                  | 20 Battery, R.A.                           |                                |             |         | 20 Battery, R.A.               |
| 138               | " "               | "        |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 139               | " "               | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                       |
| 140               | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 141               | " "               | "        |                                  | 22 Battery, R.A.                           |                                |             |         | 22 Battery, R.A.               |
| 144               | " "               | "        |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 145               | " "               | "        |                                  | 19 Battery, R.H.A.                         |                                |             |         | 19 Battery, R.A.               |
| 146               | " "               | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Valourous."            |
| 148               | " "               | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                       |
| 149               | " "               | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Valourous."            |
| 150               | " "               | "        |                                  | Halifax -                                  |                                |             |         | Halifax.                       |
| 151               | " "               | "        |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 153               | " "               | "        |                                  | Do. -                                      |                                |             |         | Do.                            |
| 154               | " "               | "        |                                  | Sydney -                                   |                                |             |         | Sydney.                        |
| 155               | " "               | "        |                                  | 22 Battery, R.A.                           |                                |             |         | 22 Battery, R.A.               |
| 156               | " "               | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                       |
| 157               | " "               | "        |                                  | 22 Battery, R.A.                           |                                |             |         | 22 Battery, R.A.               |
| 159               | " "               | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Valourous."            |



Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun.   | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.     |
|-------------------|------------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|----------------------|
|                   |                  |          |                                  |                                            |                                | Alteration. | Repair. |                      |
|                   |                  |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                      |
| 160               | 40-pounder, Long | R. G. F. |                                  | Portsmouth -                               |                                |             |         | Portsmouth.          |
| 161               | "                | "        |                                  | Halifax -                                  |                                |             |         | Halifax.             |
| 162               | "                | "        |                                  | 22 Battery, R.A. -                         |                                |             |         | 22 Battery, R.A.     |
| 163               | "                | "        |                                  | R.M., Plymouth -                           |                                |             |         | R.M., Plymouth.      |
| 164               | "                | "        |                                  | Halifax -                                  |                                |             |         | Halifax.             |
| 165               | "                | "        |                                  | Do. -                                      |                                |             |         | Do.                  |
| 167               | "                | "        |                                  | 23 Battery, R.A. -                         |                                |             |         | 23 Battery, R.A.     |
| 168               | "                | "        |                                  | Do. -                                      |                                |             |         | Do.                  |
| 169               | "                | "        |                                  | Halifax -                                  |                                |             |         | Halifax.             |
| 170               | "                | "        |                                  | Devonport -                                |                                |             |         | Devonport.           |
| 171               | "                | "        |                                  | Halifax -                                  |                                |             |         | Halifax.             |
| 174               | "                | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.          |
| 175               | "                | "        |                                  | Halifax -                                  |                                |             |         | Halifax.             |
| 177               | "                | "        |                                  | Do. -                                      |                                |             |         | Do.                  |
| 178               | "                | "        |                                  | 24 Battery, R.A. -                         |                                |             |         | 24 Battery, R.A.     |
| 179               | "                | "        |                                  | Chatham -                                  |                                |             |         | Chatham.             |
| 180               | "                | "        |                                  | Do. -                                      |                                |             |         | Do.                  |
| 181               | "                | "        |                                  | 25 Battery, R.A. -                         |                                |             |         | 25 Battery, R.A.     |
| 183               | "                | "        |                                  | Devonport -                                |                                |             |         | Devonport.           |
| 184               | "                | "        |                                  | 24 Battery, R.A. -                         |                                |             |         | 24 Battery, R.A.     |
| 185               | "                | "        |                                  | Devonport -                                |                                |             |         | Devonport.           |
| 187               | "                | "        |                                  | 24 Battery, R.A. -                         |                                |             |         | 24 Battery, R.A.     |
| 188               | "                | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Orontes."    |
| 189               | "                | "        |                                  | 23 Battery, R.A. -                         |                                |             |         | 23 Battery, R.A.     |
| 190               | "                | "        |                                  | Do. -                                      |                                |             |         | Do.                  |
| 191               | "                | "        |                                  | 25 " " -                                   |                                |             |         | 25 " "               |
| 192               | "                | "        |                                  | Chatham -                                  |                                |             |         | Chatham.             |
| 193               | "                | "        |                                  | Do. -                                      |                                |             |         | Do.                  |
| 194               | "                | "        |                                  | Devonport -                                |                                |             |         | Devonport.           |
| 196               | "                | "        |                                  | Do. -                                      |                                |             |         | Do.                  |
| 197               | "                | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.          |
| 198               | "                | "        |                                  | 25 Battery, R.A. -                         |                                |             |         | 25 Battery, R.A.     |
| 199               | "                | "        |                                  | Devonport -                                |                                |             |         | Devonport.           |
| 200               | "                | "        |                                  | Portsmouth -                               |                                |             |         | } Portsmouth.        |
| 203               | "                | "        |                                  | Do. -                                      |                                |             |         |                      |
| 204               | "                | "        |                                  | Do. -                                      |                                |             |         |                      |
| 206               | "                | "        |                                  | Do. -                                      |                                |             |         |                      |
| 208               | "                | "        |                                  | Do. -                                      |                                |             |         |                      |
| 1                 | 110-pounder-     | R. G. F. | 44                               | Devonport -                                |                                |             |         | H.M.S. "Alacrity."   |
| 2                 | "                | "        |                                  | Do. -                                      |                                |             |         | " "Revenge."         |
| 3                 | "                | "        |                                  | H.M.S. "Excellent"                         |                                | 44 18 0     | - - -   | } Portsmouth.        |
| 4                 | "                | "        |                                  | Portsmouth -                               |                                |             |         |                      |
| 5                 | "                | "        | 15                               | Do. -                                      |                                |             |         | H.M.S. "Mersey."     |
| 6                 | "                | "        |                                  | Shoeburyness -                             |                                |             |         | Portsmouth.          |
| 7                 | "                | "        |                                  | O.S. Committee -                           |                                |             |         | } Browdown Battery.  |
| 8                 | "                | "        |                                  | Browdown Battery -                         |                                |             |         |                      |
| 9                 | "                | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Emerald."    |
| 10                | "                | "        |                                  | Do. -                                      |                                |             |         | " "Donegal."         |
| 11                | "                | "        |                                  | Do. -                                      |                                |             |         | " "Jason."           |
| 12                | "                | "        |                                  | Do. -                                      |                                |             |         | " "Conqueror."       |
| 13                | "                | "        |                                  | Do. -                                      |                                |             |         | " "Orlando."         |
| 14                | "                | "        | 313                              | Shoeburyness -                             |                                | - - -       | 93 2 1½ | " "Narcissus."       |
| 15                | "                | "        |                                  | Yaverland Battery -                        |                                |             |         | } Yaverland Battery. |
| 16                | "                | "        |                                  | Portsmouth -                               |                                |             |         |                      |
| 17                | "                | "        | 6                                | Devonport -                                |                                |             |         | Portsmouth.          |
| 18                | "                | "        | 200                              | Portsmouth -                               |                                |             |         | H.M.S. "Satellite."  |
| 19                | "                | "        |                                  | Do. -                                      |                                |             |         | Chatham.             |
| 20                | "                | "        |                                  | Portsmouth -                               |                                | 2 17 9¼     | - - -   | Proving V. pieces.   |
| 21                | "                | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Orlando."    |
| 22                | "                | "        |                                  | Portsmouth -                               |                                |             |         | " "Hannibal."        |
| 23                | "                | "        | 378                              | Do. -                                      |                                |             |         | } Shoeburyness.      |
| 24                | "                | "        |                                  | Shoeburyness -                             |                                |             |         |                      |
| 25                | "                | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.          |
| 26                | "                | "        |                                  | Tynemouth -                                |                                |             |         | Tynemouth.           |
| 27                | "                | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Hannibal."   |
| 28                | "                | "        |                                  | Do. -                                      |                                |             |         | Portsmouth.          |
| 29                | "                | "        | 26                               | Devonport -                                |                                |             |         | H.M.S. "Geyser."     |
| 30                | "                | "        |                                  | Do. -                                      |                                |             |         | " "Magicienne."      |
| 31                | "                | "        |                                  | Chatham -                                  |                                |             |         | " "Britomart."       |
| 32                | "                | "        |                                  | Devonport -                                |                                |             |         | " "Immortalité."     |
| 33                | "                | "        |                                  | Chatham -                                  |                                |             |         | " "Orpheus."         |
| 34                | "                | "        |                                  | Do. -                                      |                                |             |         | " "Cormorant."       |
| 35                | "                | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.          |
| 36                | "                | "        |                                  | Do. -                                      |                                |             |         | Do.                  |
| 37                | "                | "        |                                  | Do. -                                      |                                |             |         | Store.               |
| 38                | "                | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Edgar."      |
| 39                | "                | "        |                                  | Devonport -                                |                                |             |         | H.M.G.B. "Spider."   |
| 40                | "                | "        |                                  | Do. -                                      |                                |             |         | " "Delight."         |
|                   | "                | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.          |
|                   | "                | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Liffey."     |
|                   | "                | "        |                                  | Portsmouth -                               |                                |             |         | H.M.G.B. "Amelia."   |
|                   | "                | "        |                                  | Chatham -                                  |                                |             |         | Chatham.             |

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.               |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|--------------------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair. |                                |
|                   |                |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                                |
| 41                | 110-pounder-   | R. G. F. |                                  | Devonport -                                |                                |             |         | Royal Marines, Devon-<br>port. |
| 42                | "              | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Ariadne."              |
| 43                | "              | "        |                                  | Do. -                                      |                                |             |         | H.M.G.B. "Sheldrake."          |
| 44                | "              | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Aboukir."              |
| 45                | "              | "        |                                  | Do. -                                      |                                |             |         | " "Ariadne."                   |
| 46                | "              | "        |                                  | Portsmouth -                               |                                |             |         | H.M.G.B. "Escort."             |
| 47                | "              | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Stromboli."            |
| 48                | "              | "        |                                  | Devonport -                                |                                |             |         | Chatham.                       |
| 49                | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.                    |
| 50                | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.                     |
| 51                | "              | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Wanderer."             |
| 52                | "              | "        |                                  | Pembroke -                                 |                                |             |         | Pembroke.                      |
| 53                | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.                    |
| 54                | "              | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "St. George."           |
| 55                | "              | "        |                                  | Do. -                                      |                                |             |         | H.M.G.B. "High-<br>lander."    |
| 56                | "              | "        |                                  | Do. -                                      |                                |             |         | H.M.G.B. "Rose."               |
| 57                | "              | "        |                                  | Do. -                                      |                                |             |         | Portsmouth.                    |
| 58                | "              | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Centurion."            |
| 59                | "              | "        |                                  | Portsmouth -                               |                                |             |         | " "Sutlej."                    |
| 60                | "              | "        |                                  | Do. -                                      |                                |             |         | " "St. George."                |
| 61                | "              | "        |                                  | Chatham -                                  |                                |             |         | " "Galatea."                   |
| 62                | "              | "        |                                  | Portsmouth -                               |                                |             |         | H.M.G.B. "Blazer."             |
| 63                | "              | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Marlborough."          |
| 64                | "              | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.                     |
| 65                | "              | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Shannon."              |
| 66                | "              | "        |                                  | Do. -                                      |                                |             |         | H.M.G.B. "Raven."              |
| 67                | "              | "        |                                  | H.M.S. "Challenger"                        |                                |             |         | H.M.S. "Challenger."           |
| 68                | "              | "        | 388                              | Shoeburyness                               | R                              |             |         | } Store.                       |
| 69                | "              | "        | "                                | Do. -                                      |                                |             |         | H.M.S. "Stromboli."            |
| 70                | "              | "        | 81                               | Portsmouth -                               |                                |             | 40 8 9  | } Chatham.                     |
| 71                | "              | "        | "                                | Do. -                                      |                                |             |         | Store.                         |
| 72                | "              | "        | 514                              | Chatham -                                  |                                |             |         | H.M.S. "Trafalgar."            |
| 73                | "              | "        | "                                | Portsmouth -                               |                                |             |         | Chatham.                       |
| 74                | "              | "        | "                                | Devonport -                                |                                |             |         | H.M.S. "Rattlesnake."          |
| 75                | "              | "        | "                                | Portsmouth -                               |                                |             |         | " "Trafalgar."                 |
| 76                | "              | "        | "                                | Devonport -                                |                                |             |         | " "Orlando."                   |
| 77                | "              | "        | "                                | Do. -                                      |                                |             |         | Malta.                         |
| 78                | "              | "        | "                                | H.M.S. "Challenger"                        |                                |             |         | H.M.S. "Challenger."           |
| 79                | "              | "        | "                                | Gibraltar -                                |                                |             |         | Gibraltar.                     |
| 80                | "              | "        | "                                | Portsmouth -                               |                                |             |         | H.M.S. "Stromboli."            |
| 81                | "              | "        | 15                               | Chatham -                                  |                                |             |         | Chatham.                       |
| 82                | "              | "        | 360                              | Shoeburyness                               |                                |             | 45 10 6 | } Shoeburyness.                |
| 83                | "              | "        | "                                | Do. -                                      |                                |             |         | H.M.S. "Medea."                |
| 84                | "              | "        | "                                | H.M.S. "Black Prince"                      |                                |             |         | Chatham.                       |
| 85                | "              | "        | "                                | Chatham -                                  |                                |             |         | Devonport.                     |
| 86                | "              | "        | "                                | Devonport -                                |                                |             |         | H.M.S. "Tribune."              |
| 87                | "              | "        | "                                | Portsmouth -                               |                                |             |         | " "Foudroyant."                |
| 88                | "              | "        | "                                | H.M.S. "Foudroyant"                        |                                |             |         | " "Aboukir."                   |
| 89                | "              | "        | "                                | " "Aboukir"                                |                                |             |         | Chatham.                       |
| 90                | "              | "        | "                                | Chatham -                                  |                                |             |         | Portsmouth.                    |
| 91                | "              | "        | 84                               | Shoeburyness                               | R                              |             | 84 10 8 | Chatham.                       |
| 92                | "              | "        | 30                               | Chatham -                                  |                                |             |         | Portsmouth.                    |
| 93                | "              | "        | "                                | Portsmouth -                               |                                |             |         | Chatham.                       |
| 94                | "              | "        | "                                | Chatham -                                  |                                |             |         | H.M.S. "Galatea."              |
| 95                | "              | "        | "                                | Do. -                                      |                                |             |         | " "Euryalus."                  |
| 96                | "              | "        | "                                | Portsmouth -                               |                                |             |         | Chatham.                       |
| 97                | "              | "        | "                                | Chatham -                                  |                                |             |         | H.M.S. "Duncan."               |
| 98                | "              | "        | "                                | Portsmouth -                               |                                |             |         | " "Emerald."                   |
| 99                | "              | "        | "                                | Do. -                                      |                                |             |         | " "Edgar."                     |
| 100               | "              | "        | "                                | Do. -                                      |                                |             |         | Portsmouth Lines.              |
| 101               | "              | "        | "                                | Portsmouth Lines                           |                                |             |         | Chatham.                       |
| 102               | "              | "        | "                                | Chatham -                                  |                                |             |         | Portsmouth.                    |
| 103               | "              | "        | "                                | Portsmouth -                               |                                |             |         | Malta.                         |
| 104               | "              | "        | "                                | Devonport -                                |                                |             |         | H.M.S. "Phaeton."              |
| 105               | "              | "        | 21                               | Chatham -                                  |                                |             |         | " "Orlando."                   |
| 106               | "              | "        | "                                | Devonport -                                |                                |             |         | Portsmouth.                    |
| 107               | "              | "        | "                                | Portsmouth -                               |                                | 4 8 7       |         | } Chatham.                     |
| 108               | "              | "        | "                                | H.M.S. "Driver"                            |                                |             |         | H.M.S. "Orestes."              |
| 109               | "              | "        | 27                               | Chatham -                                  |                                |             |         | Chatham.                       |
| 110               | "              | "        | "                                | Do. -                                      |                                |             |         | Do.                            |
| 111               | "              | "        | "                                | Do. -                                      |                                |             |         | H.M.S. "Hannibal."             |
| 112               | "              | "        | "                                | Portsmouth -                               |                                |             |         | Chatham.                       |
| 113               | "              | "        | "                                | Chatham -                                  |                                |             |         | H.M.G.B. "Bulldog."            |
| 114               | "              | "        | "                                | Portsmouth -                               |                                |             |         | Chatham.                       |
| 115               | "              | "        | "                                | Chatham -                                  |                                |             |         | Do.                            |
| 116               | "              | "        | "                                | Do. -                                      |                                |             |         | Do.                            |
| 117               | "              | "        | "                                | Do. -                                      |                                |             |         | H.M.S. "Sutlej."               |
| 118               | "              | "        | "                                | Portsmouth -                               |                                |             |         | H.M.G.B. "Lively."             |
| 119               | "              | "        | "                                | Chatham -                                  |                                |             |         | Chatham.                       |
| 120               | "              | "        | "                                | Do. -                                      |                                |             |         | Do.                            |
| 122               | "              | "        | "                                | Do. -                                      |                                |             |         | H.M.S. "Black Prince."         |
| 123               | "              | "        | "                                | Portsmouth -                               |                                |             |         |                                |



Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |           | Present Station.            |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|-----------|-----------------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair.   |                             |
|                   |                |          |                                  |                                            |                                | £ s. d.     | £ s. d.   |                             |
| 124               | 110-pounder -  | R. G. F. |                                  | Chatham -                                  |                                |             |           | Chatham.                    |
| 125               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | Portsmouth.                 |
| 126               | " -            | "        |                                  | Chatham -                                  |                                |             |           | Chatham.                    |
| 127               | " -            | "        |                                  | Do. -                                      |                                |             |           | H.M.G.B. "Griper."          |
| 128               | " -            | "        |                                  | Do. -                                      |                                |             |           | " "Julia."                  |
| 129               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | H.M.S. "Excellent."         |
| 130               | " -            | "        |                                  | Chatham -                                  |                                |             |           | Chatham.                    |
| 131               | " -            | "        |                                  | Do. -                                      |                                |             |           | Do.                         |
| 132               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | H.M.G.B. "Swinger."         |
| 133               | " -            | "        |                                  | Devonport -                                |                                |             |           | " "Heron."                  |
| 134               | " -            | "        |                                  | Chatham -                                  |                                |             |           | Chatham.                    |
| 135               | " -            | "        | 309                              | Shoeburyness                               |                                | 1 16 9      |           | Store.                      |
| 136               | " -            | "        |                                  | Chatham -                                  |                                |             |           | Chatham.                    |
| 137               | " -            | "        |                                  | Do. -                                      |                                |             |           | Rl. Marines, Chatham.       |
| 138               | " -            | "        |                                  | Do. -                                      |                                |             |           | H.M.S. "Galatea."           |
| 139               | " -            | "        |                                  | Do. -                                      |                                |             |           | Chatham.                    |
| 140               | " -            | "        |                                  | Do. -                                      |                                |             |           | Do.                         |
| 141               | " -            | "        |                                  | Do. -                                      |                                |             |           | Do.                         |
| 142               | " -            | "        |                                  | Do. -                                      |                                |             |           | Do.                         |
| 143               | " -            | "        |                                  | Do. -                                      |                                |             |           | H.M.S. "Galatea."           |
| 144               | " -            | "        | 368                              | Shoeburyness                               |                                | 34 7 2      | 89 10 11½ | } Store.                    |
| 145               | " -            | "        |                                  | " -                                        |                                |             |           | H.M.S. "Sandfly."           |
| 146               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | Portsmouth.                 |
| 147               | " -            | "        | 431                              | Devonport                                  |                                |             |           | Store.                      |
| 148               | " -            | "        | 28                               | Eastney Battery                            |                                |             |           | Eastney Battery.            |
| 149               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | Portsmouth.                 |
| 150               | " -            | "        |                                  | St. Nicholas Island                        |                                |             |           | St. Nicholas Island.        |
| 151               | " -            | "        |                                  | Devonport -                                |                                |             |           | H.M.S. "Princess<br>Royal." |
| 152               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | H.M.S. "Emerald."           |
| 153               | " -            | "        |                                  | Bombay -                                   |                                |             |           | Bombay.                     |
| 154               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | Portsmouth.                 |
| 155               | " -            | "        |                                  | Do. -                                      |                                |             |           | "                           |
| 156               | " -            | "        |                                  | Chatham -                                  |                                |             |           | Chatham.                    |
| 157               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | Portsmouth.                 |
| 158               | " -            | "        |                                  | Do. -                                      |                                |             |           | Do.                         |
| 159               | " -            | "        |                                  | Do. -                                      |                                |             |           | H.M.S. "Sutlej."            |
| 160               | " -            | "        |                                  | Do. -                                      |                                |             |           | " "Emerald."                |
| 161               | " -            | "        |                                  | Chatham -                                  |                                |             |           | " "Severn."                 |
| 162               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | H.M.G.B. "Jasper."          |
| 163               | " -            | "        |                                  | Do. -                                      |                                |             |           | Portsmouth.                 |
| 164               | " -            | "        |                                  | Do. -                                      |                                |             |           | Do.                         |
| 165               | " -            | "        |                                  | Do. -                                      |                                |             |           | H.M.S. "Racehorse."         |
| 166               | " -            | "        |                                  | Do. -                                      |                                |             |           | " "Charger."                |
| 167               | " -            | "        | 95                               | Devonport                                  |                                |             |           | Store.                      |
| 168               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | Portsmouth.                 |
| 169               | " -            | "        |                                  | Do. -                                      |                                |             |           | H.M.S. "Sutlej."            |
| 170               | " -            | "        |                                  | Devonport -                                |                                |             |           | Devonport.                  |
| 171               | " -            | "        |                                  | Chatham -                                  |                                |             |           | Chatham.                    |
| 172               | " -            | "        |                                  | Do. -                                      |                                |             |           | H.M.S. "Sepoy."             |
| 173               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | Portsmouth.                 |
| 174               | " -            | "        |                                  | Do. -                                      |                                |             |           | Do.                         |
| 175               | " -            | "        |                                  | Chatham -                                  |                                |             |           | Chatham.                    |
| 176               | " -            | "        |                                  | Do. -                                      |                                |             |           | Do.                         |
| 177               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | H.M.S. "Coquette."          |
| 178               | " -            | "        |                                  | Do. -                                      |                                |             |           | Portsmouth.                 |
| 179               | " -            | "        |                                  | Devonport -                                |                                |             |           | Devonport.                  |
| 180               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | Portsmouth.                 |
| 181               | " -            | "        |                                  | Devonport -                                |                                |             |           | H.M.S. "Gibraltar."         |
| 182               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | Portsmouth.                 |
| 183               | " -            | "        |                                  | Bombay -                                   |                                |             |           | Bombay.                     |
| 184               | " -            | "        |                                  | Chatham -                                  |                                |             |           | Chatham.                    |
| 185               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | Portsmouth.                 |
| 186               | " -            | "        | 53                               | Devonport -                                |                                |             |           | H.M.S. "Magicienne."        |
| 187               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | " "Emerald."                |
| 189               | " -            | "        |                                  | Chatham -                                  |                                |             |           | " "Galatea."                |
| 190               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | H.M.G.B. "Foam."            |
| 191               | " -            | "        | 30                               | Chatham -                                  |                                |             |           | Chatham.                    |
| 192               | " -            | "        |                                  | { O. S. Committee                          |                                | 1 17 10     | 54 18 0   | } Do.                       |
| 193               | " -            | "        |                                  | Chatham -                                  |                                |             |           | Portsmouth.                 |
| 194               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | H.M.S. "Liverpool."         |
| 195               | " -            | "        |                                  | Devonport -                                |                                |             |           | Portsmouth.                 |
| 196               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | Portsmouth.                 |
| 197               | " -            | "        |                                  | Pembroke -                                 |                                |             |           | Pembroke.                   |
| 198               | " -            | "        |                                  | Chatham -                                  |                                |             |           | Chatham.                    |
| 199               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | Portsmouth.                 |
| 200               | " -            | "        |                                  | Do. -                                      |                                |             |           | Do.                         |
| 201               | " -            | "        | 13                               | Do. -                                      | ↑                              |             |           | Chatham.                    |
| 202               | " -            | "        |                                  | Commandant                                 |                                |             |           | Commandant.                 |
| 203               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | Portsmouth.                 |
| 204               | " -            | "        |                                  | Chatham -                                  |                                |             |           | H.M.S. "Virago."            |
| 205               | " -            | "        | 40                               | O. S. Committee                            |                                |             |           | Store.                      |
| 206               | " -            | "        | 95                               | Dover -                                    |                                |             |           | Dover.                      |
| 207               | " -            | "        |                                  | Portsmouth -                               |                                |             |           | Portsmouth.                 |
| 208               | " -            | "        | 21                               | Bermuda -                                  |                                |             |           | Bermuda.                    |
|                   | " -            | "        |                                  | Shoeburyness                               | ↑                              |             |           | Shoeburyness.               |

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.       |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|------------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair. |                        |
|                   |                |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                        |
| 209               | 110-pounder-   | R. G. F. |                                  | Devonport -                                |                                |             |         | H.M.G.B. "Charon."     |
| 210               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 211               | "              | "        | 132                              | Shoeburyness -                             | ↑                              | 2 5 0       | - - -   | Store.                 |
| 212               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 213               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 214               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth             |
| 215               | "              | "        | 102                              | Malta -                                    |                                |             |         | Malta.                 |
| 216               | "              | "        |                                  | Portsmouth -                               |                                |             |         | H.M.G.B. "Earnest."    |
| 217               | "              | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Curaçoa."      |
| 218               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 219               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 220               | "              | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Royal Oak."    |
| 221               | "              | "        |                                  | Dover -                                    |                                |             |         | Dover.                 |
| 222               | "              | "        |                                  | Devonport -                                |                                |             |         | H.M.G.B. "Clinker."    |
| 223               | "              | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Valourous."    |
| 224               | "              | "        |                                  | Chatham -                                  |                                |             |         | H.M.G.B. "Mistletoe."  |
| 225               | "              | "        |                                  | Do. -                                      |                                |             |         | Chatham.               |
| 226               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 227               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 228               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 229               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 230               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 231               | "              | "        | 38                               | Chatham -                                  |                                |             |         | H.M.S. "Royal Oak."    |
| 232               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 233               | "              | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.             |
| 234               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 235               | "              | "        |                                  | Lumps Fort -                               |                                |             |         | Lumps Fort.            |
| 236               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 237               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 238               | "              | "        |                                  | Roy. Mar., Woolwich                        |                                |             |         | Roy. Mar., Woolwich.   |
| 239               | "              | "        |                                  | Lumps Fort -                               |                                |             |         | Lumps Fort.            |
| 240               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 241               | "              | "        |                                  | Fort Victoria                              |                                |             |         | Fort Victoria.         |
| 242               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 243               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 244               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 245               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.            |
| 246               | "              | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.             |
| 247               | "              | "        | 58                               | Shoeburyness                               |                                |             |         | Shoeburyness.          |
| 248               | "              | "        | 2                                | Malta -                                    |                                |             |         | Malta.                 |
| 249               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 250               | "              | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.             |
| 251               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 252               | "              | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.             |
| 253               | "              | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Styx."         |
| 254               | "              | "        |                                  | Cliffend Fort                              |                                |             |         | Cliffend Fort.         |
| 255               | "              | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Black Prince." |
| 256               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 257               | "              | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Leopard."      |
| 258               | "              | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 259               | "              | "        | 27                               | Cliffend Fort                              |                                |             |         | Cliffend Fort.         |
| 260               | "              | "        |                                  | Sheerness -                                |                                |             |         | Sheerness.             |
| 261               | "              | "        |                                  | Southsea Castle                            |                                |             |         | Southsea Castle.       |
| 262               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 263               | "              | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.             |
| 264               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 265               | "              | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Barossa."      |
| 266               | "              | "        |                                  | Southsea Castle                            |                                |             |         | Southsea Castle.       |
| 267               | "              | "        | 22                               | Malta -                                    |                                |             |         | Malta.                 |
| 268               | "              | "        |                                  | Tynemouth -                                |                                |             |         | Tynemouth.             |
| 269               | "              | "        |                                  | Southsea Castle                            |                                |             |         | Southsea Castle.       |
| 270               | "              | "        | 95                               | Sheerness -                                |                                |             |         | Sheerness.             |
| 271               | "              | "        | 50                               | Shoeburyness                               |                                | 3 9 3       | - - -   | H.M.S. "Euryalus."     |
| 272               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 273               | "              | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Leopard."      |
| 274               | "              | "        |                                  | Corfu -                                    |                                |             |         | Corfu.                 |
| 275               | "              | "        |                                  | Lumps Fort -                               |                                |             |         | Lumps Fort.            |
| 276               | "              | "        | 26                               | Sheerness -                                |                                |             |         | Sheerness.             |
| 277               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 278               | "              | "        | 34                               | Gibraltar -                                |                                |             |         | Gibraltar.             |
| 279               | "              | "        |                                  | Southsea Castle                            |                                |             |         | Southsea Castle.       |
| 280               | "              | "        |                                  | Pembroke -                                 |                                |             |         | Pembroke.              |
| 281               | "              | "        |                                  | Sheerness -                                |                                |             |         | Sheerness.             |
| 282               | "              | "        | 38                               | Gibraltar -                                |                                |             |         | Gibraltar.             |
| 283               | "              | "        | 18                               | Corfu -                                    |                                |             |         | Corfu.                 |
| 284               | "              | "        |                                  | Tynemouth -                                |                                |             |         | Tynemouth.             |
| 285               | "              | "        |                                  | Fort Monkton                               |                                |             |         | Fort Monkton.          |
| 286               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 287               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 288               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 289               | "              | "        |                                  | Block House Fort                           |                                |             |         | Block House Fort.      |
| 290               | "              | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.             |
| 291               | "              | "        |                                  | Malta -                                    |                                |             |         | Malta.                 |
| 292               | "              | "        | 17                               | Do. -                                      |                                |             |         | Do.                    |
| 293               | "              | "        |                                  | Tynemouth -                                |                                |             |         | Tynemouth.             |
| 294               | "              | "        |                                  | Malta -                                    |                                |             |         | Malta.                 |



Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.            |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|-----------------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair. |                             |
|                   |                |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                             |
| 295               | 110-pounder -  | R. G. F. | 26                               | Malta -                                    | -                              |             |         | Malta.                      |
| 296               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                  |
| 297               | " -            | "        | 24                               | Sheerness -                                | -                              |             |         | Sheerness.                  |
| 298               | " -            | "        |                                  | Corfu -                                    | -                              |             |         | Corfu.                      |
| 299               | " -            | "        |                                  | Southsea Castle -                          | -                              |             |         | Southsea Castle.            |
| 300               | " -            | "        |                                  | Fort Monkton -                             | -                              |             |         | Fort Monkton.               |
| 301               | " -            | "        |                                  | Sheerness -                                | -                              |             |         | Sheerness.                  |
| 302               | " -            | "        | 81                               | Plymouth -                                 | -                              |             |         | Plymouth.                   |
| 303               | " -            | "        |                                  | Malta -                                    | -                              |             |         | Malta.                      |
| 304               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 305               | " -            | "        |                                  | Malta -                                    | -                              |             |         | Malta.                      |
| 306               | " -            | "        |                                  | Southsea Castle -                          | -                              |             |         | Southsea Castle.            |
| 307               | " -            | "        | 84                               | Plymouth -                                 | -                              |             |         | Plymouth.                   |
| 308               | " -            | "        |                                  | Sheerness -                                | -                              |             |         | Sheerness.                  |
| 309               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                         |
| 310               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                         |
| 311               | " -            | "        |                                  | Plymouth -                                 | -                              |             |         | Plymouth.                   |
| 312               | " -            | "        |                                  | Gibraltar -                                | -                              |             |         | Gibraltar.                  |
| 313               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                         |
| 314               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Black Prince."      |
| 315               | " -            | "        | 73                               | Gibraltar -                                | -                              |             |         | Gibraltar.                  |
| 316               | " -            | "        |                                  | Lumps Fort -                               | -                              |             |         | Lumps Fort.                 |
| 317               | " -            | "        |                                  | Perch Rock Battery -                       | -                              |             |         | Perch Rock Battery.         |
| 318               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Black Prince."      |
| 319               | " -            | "        |                                  | Gibraltar -                                | -                              |             |         | Gibraltar.                  |
| 320               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Black Prince."      |
| 321               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                  |
| 322               | " -            | "        |                                  | Gibraltar -                                | -                              |             |         | Gibraltar.                  |
| 323               | " -            | "        |                                  | Malta -                                    | -                              |             |         | Malta.                      |
| 324               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                  |
| 325               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                         |
| 326               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                 |
| 327               | " -            | "        |                                  | Gibraltar -                                | -                              |             |         | Gibraltar.                  |
| 329               | " -            | "        | 22                               | Malta -                                    | -                              |             |         | Malta.                      |
| 330               | " -            | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Severn."            |
| 331               | " -            | "        |                                  | Gibraltar -                                | -                              |             |         | Gibraltar.                  |
| 332               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 333               | " -            | "        | 36                               | H.M.S. "Melpomene" -                       | -                              |             |         | H.M.S. "Black Prince."      |
| 334               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 335               | " -            | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Racoon."            |
| 336               | " -            | "        |                                  | Bermuda -                                  | -                              |             |         | Bermuda.                    |
| 337               | " -            | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Phoebe."            |
| 338               | " -            | "        |                                  | Freshwater Redoubt -                       | -                              |             |         | Freshwater Redoubt.         |
| 339               | " -            | "        |                                  | Southsea Castle -                          | -                              |             |         | Southsea Castle.            |
| 340               | " -            | "        | 38                               | Gibraltar -                                | -                              |             |         | Gibraltar.                  |
| 341               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Tribune."           |
| 342               | " -            | "        |                                  | Brown-down Battery -                       | -                              |             |         | Brown-down Battery.         |
| 343               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Sutlej."            |
| 344               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 345               | " -            | "        |                                  | Cliffend Fort -                            | -                              |             |         | Cliffend Fort.              |
| 346               | " -            | "        | 10                               | Alderney -                                 | -                              |             |         | Alderney.                   |
| 347               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                         |
| 348               | " -            | "        |                                  | Southsea Castle -                          | -                              |             |         | Southsea Castle.            |
| 349               | " -            | "        | 11                               | Malta -                                    | -                              |             |         | Malta.                      |
| 350               | " -            | "        |                                  | Gibraltar -                                | -                              |             |         | Gibraltar.                  |
| 351               | " -            | "        |                                  | H.M.S. "Doteril" -                         | -                              |             |         | H.M.S. "Doteril."           |
| 352               | " -            | "        |                                  | Gibraltar -                                | -                              |             |         | Gibraltar.                  |
| 353               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Frederick William." |
| 354               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 355               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                         |
| 356               | " -            | "        |                                  | Gibraltar -                                | -                              |             |         | Gibraltar.                  |
| 357               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Resistance."        |
| 358               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                  |
| 359               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Resistance."        |
| 360               | " -            | "        | 19                               | Do. -                                      | -                              |             |         | " "Pylades."                |
| 361               | " -            | "        |                                  | Gibraltar -                                | -                              |             |         | Gibraltar.                  |
| 362               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                 |
| 363               | " -            | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Leopard."           |
| 364               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 365               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                 |
| 366               | " -            | "        |                                  | H.M.S. "Immortalité" -                     | -                              |             |         | H.M.S. "Immortalité."       |
| 367               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 368               | " -            | "        | 33                               | Do. -                                      | -                              |             |         | Do.                         |
| 369               | " -            | "        | 11                               | Gibraltar -                                | -                              |             |         | Gibraltar.                  |
| 370               | " -            | "        |                                  | Eastney Battery -                          | -                              |             |         | Eastney Battery.            |
| 371               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Black Prince."      |
| 372               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                         |
| 373               | " -            | "        | 150                              | O. S. Committee -                          | -                              | 3 5 6       | - - -   | } Shoeburyness.             |
| 374               | " -            | "        |                                  | Shoeburyness -                             | -                              |             |         | H.M.S. "Phoebe."            |
| 375               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Dover.                      |
| 376               | " -            | "        |                                  | Dover -                                    | -                              |             |         | Portsmouth.                 |
| 377               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Sutlej."            |
| 378               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Gibraltar.                  |
| 379               | " -            | "        |                                  | Gibraltar -                                | -                              |             |         | H.M.S. "Black Prince."      |
| 380               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | Gibraltar.                  |
|                   |                |          |                                  | Gibraltar -                                | -                              |             |         | Gibraltar.                  |

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station             |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|-----------------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair. |                             |
|                   |                |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                             |
| 381               | 110-pounder-   | R. G. F. |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Black Prince."      |
| 382               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.                  |
| 383               | "              | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Frederick William." |
| 384               | "              | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Phoebe."            |
| 385               | "              | "        |                                  | Do. -                                      |                                |             |         | Devonport.                  |
| 386               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.                 |
| 387               | "              | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.                  |
| 388               | "              | "        |                                  | Bermuda -                                  |                                |             |         | Bermuda.                    |
| 389               | "              | "        | 33                               | Dover -                                    |                                |             |         | Dover.                      |
| 390               | "              | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Euryalus."          |
| 391               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.                 |
| 392               | "              | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                    |
| 393               | "              | "        |                                  | Bermuda -                                  |                                |             |         | Bermuda.                    |
| 394               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.                  |
| 395               | "              | "        |                                  | Bermuda -                                  |                                |             |         | Bermuda.                    |
| 396               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.                  |
| 397               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                         |
| 398               | "              | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.                  |
| 399               | "              | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                    |
| 400               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.                  |
| 401               | "              | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Phoebe."            |
| 402               | "              | "        |                                  | Do. -                                      |                                |             |         | Devonport.                  |
| 403               | "              | "        | 9                                | Do. -                                      |                                |             |         | Do.                         |
| 404               | "              | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                    |
| 405               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.                 |
| 406               | "              | "        | 16                               | Bombay -                                   |                                |             |         | Bombay.                     |
| 407               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.                 |
| 408               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.                  |
| 409               | "              | "        | 77                               | O. S. Committee<br>Shoeburyness            |                                |             |         | Shoeburyness.               |
| 410               | "              | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Euryalus."          |
| 411               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.                 |
| 412               | "              | "        |                                  | Bermuda -                                  |                                |             |         | Bermuda.                    |
| 413               | "              | "        |                                  | Portsmouth -                               |                                |             |         | H.M.G.B. "Tyrian."          |
| 414               | "              | "        |                                  | Eastney Battery                            |                                |             |         | Eastney Battery.            |
| 415               | "              | "        |                                  | Bermuda -                                  |                                |             |         | Bermuda.                    |
| 416               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                         |
| 417               | "              | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                    |
| 418               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.                  |
| 419               | "              | "        |                                  | Commandant                                 |                                |             |         | Commandant.                 |
| 420               | "              | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Royal Oak."         |
| 421               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.                  |
| 422               | "              | "        | 36                               | Gibraltar -                                |                                |             |         | Gibraltar.                  |
| 423               | "              | "        |                                  | Malta -                                    |                                |             |         | Malta.                      |
| 424               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.                  |
| 425               | "              | "        | 80                               | O.S. Committee<br>Fort Cumberland          |                                | 2 5 6       | - - -   | Fort Cumberland.            |
| 426               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.                  |
| 427               | "              | "        |                                  | Bermuda -                                  |                                |             |         | Bermuda.                    |
| 428               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                         |
| 429               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                         |
| 430               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                         |
| 431               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.                  |
| 432               | "              | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.                  |
| 433               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                         |
| 434               | "              | "        |                                  | Malta -                                    |                                |             |         | Malta.                      |
| 435               | "              | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Canopus."           |
| 436               | "              | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.                 |
| 437               | "              | "        |                                  | Fort Cumberland                            |                                |             |         | Fort Cumberland.            |
| 438               | "              | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Leopard."           |
| 439               | "              | "        |                                  | Do. -                                      |                                |             |         | Devonport.                  |
| 440               | "              | "        | 30                               | Corfu -                                    |                                |             |         | Corfu.                      |
| 441               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.                  |
| 442               | "              | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Blk. Prince."       |
| 443               | "              | "        |                                  | Do. -                                      |                                |             |         | " "Royal Oak."              |
| 444               | "              | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.                  |
| 445               | "              | "        | 40                               | Do. -                                      |                                |             |         | Do.                         |
| 446               | "              | "        |                                  | Alderney -                                 |                                |             |         | Alderney.                   |
| 447               | "              | "        |                                  | Bermuda -                                  |                                |             |         | Bermuda.                    |
| 448               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                         |
| 449               | "              | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                    |
| 450               | "              | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Shaunon."           |
| 451               | "              | "        | 14                               | H.M.S. "Melpomene"                         |                                |             |         | " "Blk. Prince."            |
| 452               | "              | "        | 72                               | St. Nicholas Island                        |                                |             |         | St. Nicholas Island.        |
| 453               | "              | "        |                                  | Malta -                                    |                                |             |         | Malta.                      |
| 454               | "              | "        |                                  | Portsmouth -                               |                                |             |         | H.M.G.B. "Albacore."        |
| 455               | "              | "        | 19                               | Malta -                                    |                                |             |         | Malta.                      |
| 456               | "              | "        |                                  | Devonport -                                |                                |             |         | Devonport.                  |
| 457               | "              | "        |                                  | Pembroke -                                 |                                |             |         | Pembroke.                   |
| 458               | "              | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.                  |
| 459               | "              | "        |                                  | Bermuda -                                  |                                |             |         | Bermuda.                    |
| 461               | "              | "        |                                  | Malta -                                    |                                |             |         | Malta.                      |
| 462               | "              | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.                  |
| 463               | "              | "        |                                  | Do. -                                      |                                |             |         | Do.                         |
| 464               | "              | "        |                                  | Bombay -                                   |                                |             |         | Bombay.                     |
| 465               | "              | "        | 1                                | Eastbourne -                               |                                |             |         | Eastbourne.                 |



Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.      |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|-----------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair. |                       |
|                   |                |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                       |
| 466               | 110-pounder -  | R. G. F. |                                  | Milford Haven -                            |                                |             |         | Milford Haven.        |
| 467               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.           |
| 468               | " -            | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.            |
| 469               | " -            | "        |                                  | H.M.S. "Immortalité" -                     |                                |             |         | H.M.S. "Immortalité." |
| 470               | " -            | "        |                                  | St. Nicholas Island -                      |                                |             |         | St. Nicholas Island.  |
| 471               | " -            | "        |                                  | Bombay -                                   |                                |             |         | Bombay.               |
| 472               | " -            | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Redwing."     |
| 473               | " -            | "        |                                  | Do. -                                      |                                |             |         | Devonport.            |
| 474               | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Resistance."  |
| 475               | " -            | "        |                                  | Milford Haven -                            |                                |             |         | Milford Haven.        |
| 476               | " -            | "        | 135                              | Shoeburyness -                             |                                |             |         | Shoeburyness.         |
| 477               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.           |
| 478               | " -            | "        |                                  | Browdown Battery -                         |                                |             |         | Browdown Battery.     |
| 480               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.              |
| 481               | " -            | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Resistance."  |
| 482               | " -            | "        | 18                               | Devonport -                                |                                |             |         | Devonport.            |
| 483               | " -            | "        |                                  | Do. -                                      |                                |             |         | Do.                   |
| 484               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Excellent."   |
| 485               | " -            | "        |                                  | Do. -                                      |                                |             |         | Portsmouth.           |
| 486               | " -            | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.            |
| 487               | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Resistance."  |
| 488               | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.            |
| 489               | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Resistance."  |
| 490               | " -            | "        | 12                               | Gibraltar -                                |                                |             |         | Gibraltar.            |
| 491               | " -            | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Leopard."     |
| 492               | " -            | "        |                                  | Milford Haven -                            |                                |             |         | Milford Haven.        |
| 494               | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.            |
| 495               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.              |
| 496               | " -            | "        |                                  | Milford Haven -                            |                                |             |         | Milford Haven.        |
| 497               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.              |
| 498               | " -            | "        | 1                                | Eastbourne -                               |                                |             |         | Eastbourne.           |
| 499               | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Erne."        |
| 500               | " -            | "        |                                  | H.M.S. "Immortalité" -                     |                                |             |         | " "Immortalité."      |
| 501               | " -            | "        |                                  | Fort Cumberland -                          |                                |             |         | Fort Cumberland.      |
| 502               | " -            | "        |                                  | St. Nicholas Island -                      |                                |             |         | St. Nicholas Island.  |
| 504               | " -            | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.            |
| 505               | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Conqueror."   |
| 506               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "BlackPrince."      |
| 507               | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.            |
| 508               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Shannon."     |
| 509               | " -            | "        |                                  | Pembroke -                                 |                                |             |         | Pembroke.             |
| 510               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Sheerness Dockyard.   |
| 511               | " -            | "        | 6                                | H.M.S. "Clio" -                            |                                |             |         | H.M.S. "Clio."        |
| 512               | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.            |
| 513               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.              |
| 514               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Shannon."     |
| 515               | " -            | "        | 3                                | H.M.S. "Melpomene" -                       |                                |             |         | " "BlackPrince."      |
| 516               | " -            | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.            |
| 517               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.           |
| 518               | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.G.B. "Lily."      |
| 519               | " -            | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Royal Oak."   |
| 520               | " -            | "        |                                  | Redcliff Battery -                         |                                |             |         | Redcliffe Battery.    |
| 521               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.              |
| 522               | " -            | "        | 52                               | Guernsey -                                 |                                |             |         | Guernsey.             |
| 523               | " -            | "        |                                  | H.M.S. "Tartar" -                          |                                |             |         | H.M.S. "Tartar."      |
| 524               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.              |
| 526               | " -            | "        |                                  | St. Nicholas Island -                      |                                |             |         | St. Nicholas Island.  |
| 527               | " -            | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.            |
| 528               | " -            | "        | 7                                | Pembroke -                                 |                                |             |         | Pembroke.             |
| 529               | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Royal Oak."   |
| 530               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Shannon."          |
| 531               | " -            | "        | 13                               | Guernsey -                                 |                                |             |         | Guernsey.             |
| 532               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.              |
| 533               | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.            |
| 534               | " -            | "        | 21                               | Dover -                                    |                                |             |         | Dover.                |
| 535               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.              |
| 536               | " -            | "        |                                  | Do. -                                      |                                |             |         | Do.                   |
| 537               | " -            | "        | 111                              | St. Nicholas Island -                      |                                |             |         | St. Nicholas Island.  |
| 538               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.              |
| 539               | " -            | "        |                                  | Bombay -                                   |                                |             |         | Bombay.               |
| 540               | " -            | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.            |
| 541               | " -            | "        |                                  | Milford Haven -                            |                                |             |         | Milford Haven.        |
| 542               | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Royal Oak."   |
| 543               | " -            | "        |                                  | Do. -                                      |                                |             |         | Chatham.              |
| 544               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.           |
| 545               | " -            | "        | 1                                | Eastbourne -                               |                                |             |         | Eastbourne.           |
| 546               | " -            | "        | 19                               | Dover -                                    |                                |             |         | Dover.                |
| 547               | " -            | "        |                                  | H.M.S. "Vesuvius" -                        |                                |             |         | H.M.S. "Vesuvius."    |
| 548               | " -            | "        |                                  | Milford Haven -                            |                                |             |         | Milford Haven.        |
| 549               | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.            |
| 550               | " -            | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.            |
| 551               | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Royal Oak."   |
| 552               | " -            | "        |                                  | St. Nicholas Island -                      |                                |             |         | St. Nicholas Island.  |
| 553               | " -            | "        | 64                               | Do. -                                      |                                |             |         | Do.                   |
| 554               | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Conqueror."   |
| 555               | " -            | "        |                                  | Gibraltar -                                |                                |             |         | Gibraltar.            |
| 556               | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.            |

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.       |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|------------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair. |                        |
|                   |                |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                        |
| 557               | 110-pounder -  | R. G. F. |                                  | Chatham -                                  | -                              |             |         | Chatham.               |
| 558               | " -            | "        |                                  | Dover -                                    | -                              |             |         | Dover.                 |
| 559               | " -            | "        | 28                               | Chatham -                                  | -                              |             |         | H.M.S. "Argus."        |
| 560               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Chatham.               |
| 561               | " -            | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Royal Oak."    |
| 562               | " -            | "        |                                  | Fort Cumberland -                          | -                              |             |         | Fort Cumberland.       |
| 563               | " -            | "        | 3                                | H.M.S. "Melpomene" -                       | -                              |             |         | H.M.S. "Black Prince." |
| 564               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.               |
| 565               | " -            | "        |                                  | Sandown Fort -                             | -                              |             |         | Sandown Fort.          |
| 566               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.             |
| 567               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Racoon."       |
| 568               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Chatham.               |
| 569               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.             |
| 570               | " -            | "        |                                  | H.M.S. "Immortalité" -                     | -                              |             |         | H.M.S. "Immortalité."  |
| 571               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.             |
| 572               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 573               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 574               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Leander."      |
| 575               | " -            | "        |                                  | Milford Haven -                            | -                              |             |         | Milford Haven.         |
| 576               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.               |
| 577               | " -            | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Royal Oak."    |
| 578               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Chatham.               |
| 580               | " -            | "        |                                  | Bombay -                                   | -                              |             |         | Bombay.                |
| 584               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 585               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 586               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 587               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 588               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 589               | " -            | "        |                                  | Popton Point Battery -                     | -                              |             |         | Popton Point Battery.  |
| 590               | " -            | "        |                                  | Bombay -                                   | -                              |             |         | Bombay.                |
| 591               | " -            | "        |                                  | Popton Point Battery -                     | -                              |             |         | Popton Point Battery.  |
| 592               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Cossack."      |
| 593               | " -            | "        |                                  | Bombay -                                   | -                              |             |         | Bombay.                |
| 594               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 595               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 596               | " -            | "        |                                  | Popton Point Battery -                     | -                              |             |         | Popton Point Battery.  |
| 597               | " -            | "        |                                  | Bombay -                                   | -                              |             |         | Bombay.                |
| 598               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 599               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Defence."      |
| 600               | " -            | "        |                                  | Sandown Fort -                             | -                              |             |         | Sandown Fort.          |
| 601               | " -            | "        |                                  | Popton Point Battery -                     | -                              |             |         | Popton Point Battery.  |
| 602               | " -            | "        |                                  | Bombay -                                   | -                              |             |         | Bombay.                |
| 603               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 604               | " -            | "        |                                  | Sandown Fort -                             | -                              |             |         | Sandown Fort.          |
| 605               | " -            | "        |                                  | Bombay -                                   | -                              |             |         | Bombay.                |
| 606               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.            |
| 607               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 608               | " -            | "        |                                  | Dover -                                    | -                              |             |         | Dover.                 |
| 609               | " -            | "        |                                  | Bombay -                                   | -                              |             |         | Bombay.                |
| 610               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 611               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 612               | " -            | "        |                                  | Shoeburyness -                             | -                              |             |         | Shoeburyness.          |
| 613               | " -            | "        |                                  | Bombay -                                   | -                              |             |         | Bombay.                |
| 614               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 615               | " -            | "        |                                  | Redcliff Battery -                         | -                              |             |         | Redcliff Battery.      |
| 616               | " -            | "        |                                  | Bombay -                                   | -                              |             |         | Bombay.                |
| 617               | " -            | "        |                                  | Popton Point Battery -                     | -                              |             |         | Popton Point Battery.  |
| 618               | " -            | "        |                                  | Bombay -                                   | -                              |             |         | Bombay.                |
| 619               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 620               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 621               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 623               | " -            | "        |                                  | Madras -                                   | -                              |             |         | Madras.                |
| 624               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 625               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 628               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.            |
| 629               | " -            | "        |                                  | Madras -                                   | -                              |             |         | Madras.                |
| 630               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Defence."      |
| 631               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Black Prince."      |
| 632               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " Do.                  |
| 633               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Defence."           |
| 634               | " -            | "        |                                  | Madras -                                   | -                              |             |         | Madras.                |
| 635               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Cossack."      |
| 637               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | " "Defence."           |
| 639               | " -            | "        |                                  | Dover -                                    | -                              |             |         | Dover.                 |
| 640               | " -            | "        |                                  | Madras -                                   | -                              |             |         | Madras.                |
| 641               | " -            | "        |                                  | H.M.S. "Phaeton" -                         | -                              |             |         | H.M.S. "Phaeton."      |
| 642               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.            |
| 643               | " -            | "        |                                  | Dover -                                    | -                              |             |         | Dover.                 |
| 644               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.            |
| 645               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                    |
| 646               | " -            | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Black Prince." |
| 647               | " -            | "        |                                  | Popton Point Battery -                     | -                              |             |         | Popton Point Battery.  |
| 648               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Defence."      |
| 649               | " -            | "        |                                  | Popton Point Battery -                     | -                              |             |         | Popton Point Battery.  |
| 650               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Defence."      |
| 652               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Portsmouth.            |
| 653               | " -            | "        |                                  | -                                          | -                              |             |         | -                      |

1 5 0 - - -



Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun.       | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of                |         | Present Station.      |
|-------------------|----------------------|----------|----------------------------------|--------------------------------------------|--------------------------------|------------------------|---------|-----------------------|
|                   |                      |          |                                  |                                            |                                | Alteration.            | Repair. |                       |
| 657               | 110-pounder -        | R. G. F. |                                  | -                                          | +                              | £ s. d.                | £ s. d. | Store.                |
| 659               | " -                  | "        |                                  | Sandown Fort                               | -                              |                        |         | Sandown Fort.         |
| 660               | " -                  | "        |                                  | Portsmouth -                               | -                              |                        |         | Portsmouth.           |
| 661               | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 662               | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 663               | " -                  | "        |                                  | -                                          | -                              |                        |         | Store.                |
| 665               | " -                  | "        |                                  | Portsmouth -                               | -                              |                        |         | Portsmouth.           |
| 666               | " -                  | "        |                                  | Yaverland Battery                          | -                              |                        |         | Yaverland Battery.    |
| 667               | " -                  | "        |                                  | Sandown Fort                               | -                              |                        |         | Sandown Fort.         |
| 668               | " -                  | "        |                                  | Yaverland Battery                          | -                              |                        |         | Yaverland Battery.    |
| 669               | " -                  | "        |                                  | Eastney Battery                            | -                              |                        |         | Eastney Battery.      |
| 671               | " -                  | "        |                                  | Dover -                                    | -                              |                        |         | Dover.                |
| 672               | " -                  | "        |                                  | Yaverland Battery                          | -                              |                        |         | Yaverland Battery.    |
| 673               | " -                  | "        |                                  | Dover -                                    | -                              |                        |         | Dover.                |
| 674               | " -                  | "        |                                  | Yaverland Battery                          | -                              |                        |         | Yaverland Battery.    |
| 676               | " -                  | "        |                                  | Redcliff Battery                           | -                              |                        |         | Redcliff Battery.     |
| 677               | " -                  | "        |                                  | Chatham -                                  | -                              |                        |         | H.M.S. "Vigilant."    |
| 678               | " -                  | "        |                                  | Redcliff Battery                           | -                              |                        |         | Redcliff Battery.     |
| 680               | " -                  | "        |                                  | Yaverland Battery                          | -                              |                        |         | Yaverland Battery.    |
| 681               | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 682               | " -                  | "        |                                  | Chatham -                                  | -                              |                        |         | Chatham.              |
| 683               | " -                  | "        | 261                              | Proving V. pieces                          | +                              |                        |         | Store.                |
| 684               | " -                  | "        |                                  | Shoeburyness                               | -                              |                        |         | Shoeburyness.         |
| 685               | " -                  | "        |                                  | Yaverland Battery                          | -                              |                        |         | Yaverland Battery.    |
| 686               | " -                  | "        |                                  | H.M.S. "Phaeton"                           | -                              |                        |         | H.M.S. "Phaeton."     |
| 690               | " -                  | "        |                                  | Chatham -                                  | -                              |                        |         | Chatham.              |
| 691               | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 693               | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 694               | " -                  | "        |                                  | Portsmouth -                               | -                              |                        |         | Portsmouth.           |
| 695               | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 696               | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 8                 | 110-pounder, Light - | R. G. F. | 50                               | Shoeburyness                               | -                              |                        |         | Shoeburyness.         |
| 27                | " -                  | "        |                                  | Hong Kong -                                | -                              |                        |         | Hong Kong.            |
| 28                | " -                  | "        | 40                               | Shoeburyness                               | -                              |                        |         | Shoeburyness.         |
| 37                | " -                  | "        |                                  | Cawsand Bay                                | -                              |                        |         | Cawsand Bay.          |
| 44                | " -                  | "        |                                  | Hong Kong -                                | -                              |                        |         | Hong Kong.            |
| 52                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 53                | " -                  | "        | 143                              | Shoeburyness                               | -                              |                        |         | Shoeburyness.         |
| 55                | " -                  | "        |                                  | O. S. Committee                            | -                              |                        |         | O. S. Committee.      |
| 58                | " -                  | "        |                                  | Hong Kong -                                | -                              |                        |         | Hong Kong.            |
| 61                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 70                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 72                | " -                  | "        |                                  | Cawsand Bay                                | -                              |                        |         | Cawsand Bay.          |
| 77                | " -                  | "        | 183                              | Shoeburyness                               | -                              |                        |         | Shoeburyness.         |
| 1                 | 40-pr., Wedge, Short | R. G. F. | 195                              | Shoeburyness<br>H.M.S. "Excellent"         | -                              | 37 14 13 $\frac{3}{4}$ | - - -   | H.M.S. "Excellent."   |
| 1                 | 12-pounder.—8 cwt. - | E. O. C. |                                  | Melbourne -                                | -                              |                        |         | Melbourne.            |
| 2                 | " -                  | "        |                                  | O. S. Committee                            | R                              | 8 12 6                 | - - -   | Store.                |
| 3                 | " -                  | "        |                                  | Melbourne -                                | -                              |                        |         | Melbourne.            |
| 4                 | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 7                 | " -                  | "        |                                  | Portsmouth -                               | -                              |                        |         | H.M.S. "Marlborough." |
| 8                 | " -                  | "        |                                  | Melbourne -                                | -                              |                        |         | Melbourne.            |
| 10                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 11                | " -                  | "        |                                  | China -                                    | -                              |                        |         | Store.                |
| 12                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 13                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | China.                |
| 14                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Store.                |
| 15                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 16                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 17                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | China.                |
| 18                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Store.                |
| 19                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | China.                |
| 20                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 21                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 22                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Do.                   |
| 23                | " -                  | "        |                                  | Portsmouth -                               | -                              |                        |         | H.M.S. "Harrier."     |
| 24                | " -                  | "        | 11                               | Do. -                                      | -                              | 8 18 0                 | - - -   | Jersey Militia Ar-    |
| 25                | " -                  | "        | 372                              | Jersey Militia Arty. -                     | -                              | 2 13 3                 | - - -   | tillery.              |
| 26                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Store.                |
| 27                | " -                  | "        |                                  | Do. -                                      | -                              |                        |         | Portsmouth.           |
| 28                | " -                  | "        | 50                               | R.C. Department                            | -                              |                        |         | R.C. Department.      |
| 29                | " -                  | "        |                                  | Portsmouth -                               | -                              |                        |         | Portsmouth.           |
| 30                | " -                  | "        | 1,039                            | Do. -                                      | R                              | 14 1 10                | 0 4 6   | Store.                |

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun.      | Maker. | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.               |
|-------------------|---------------------|--------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|--------------------------------|
|                   |                     |        |                                  |                                            |                                | Alteration. | Repair. |                                |
| 31                | 12-pounder.—8 cwt.— | E.O.C. |                                  | Portsmouth -                               |                                | £ s. d.     | £ s. d. | H.M.S. "Medea."                |
| 32                | " "                 | "      | 89 {                             | Do. -                                      |                                | 8 18 0      | - - -   | Jersey Militia Ar-<br>tillery. |
| 33                | " "                 | "      |                                  | Jersey Militia Arty. -                     |                                |             |         | H.M.S. "Excellent."            |
| 34                | " "                 | "      | 118 {                            | Portsmouth -                               | +                              |             |         | Store.                         |
| 35                | " "                 | "      |                                  | O. S. Committee -                          |                                |             |         | H.M.S. "Gibraltar."            |
| 36                | " "                 | "      | 310 {                            | Devonport -                                | R                              |             |         | Devonport.                     |
| 37                | " "                 | "      |                                  | Do. -                                      |                                |             |         | H.M.S. "Orlando."              |
| 38                | " "                 | "      |                                  | R.C. Department -                          |                                |             |         | R.C. Department.               |
| 39                | " "                 | "      |                                  | Devonport -                                |                                |             |         | H.M.S. "Cambridge."            |
| 40                | " "                 | "      | 100 {                            | O. S. Committee -                          | R                              | 80 14 5½    | - - -   | Royal Gun Factories.           |
| 41                | " "                 | "      |                                  | Do. -                                      |                                |             |         | Devonport.                     |
| 42                | " "                 | "      |                                  | Devonport -                                | R                              |             |         | H.M.S. "Euryalus."             |
| 43                | " "                 | "      |                                  | Do. -                                      |                                |             |         | Royal Laboratory.              |
| 44                | " "                 | "      |                                  | Royal Laboratory -                         |                                |             |         | Calcutta.                      |
| 45                | " "                 | "      |                                  | Calcutta -                                 |                                |             |         | Madras.                        |
| 46                | " "                 | "      |                                  | Madras -                                   |                                |             |         | Bombay.                        |
| 47                | " "                 | "      |                                  | Bombay -                                   |                                |             |         | Do.                            |
| 48                | " "                 | "      |                                  | Do. -                                      |                                |             |         | Madras.                        |
| 49                | " "                 | "      |                                  | Madras -                                   |                                |             |         | Bombay.                        |
| 51                | " "                 | "      |                                  | Bombay -                                   |                                |             |         | Madras.                        |
| 52                | " "                 | "      |                                  | Madras -                                   |                                |             |         | Calcutta.                      |
| 53                | " "                 | "      |                                  | Calcutta -                                 |                                |             |         | Bombay.                        |
| 54                | " "                 | "      |                                  | Bombay -                                   |                                |             |         | Calcutta.                      |
| 55                | " "                 | "      |                                  | Calcutta -                                 |                                |             |         | Bombay.                        |
| 56                | " "                 | "      |                                  | Bombay -                                   |                                |             |         | Calcutta.                      |
| 57                | " "                 | "      |                                  | Calcutta -                                 |                                |             |         | Bombay.                        |
| 58                | " "                 | "      |                                  | Bombay -                                   |                                |             |         | Calcutta.                      |
| 59                | " "                 | "      |                                  | Calcutta -                                 | R                              |             |         | Bombay.                        |
| 60                | " "                 | "      |                                  | Bombay -                                   |                                |             |         | Madras.                        |
| 61                | " "                 | "      |                                  | Madras -                                   |                                |             |         | Calcutta.                      |
| 62                | " "                 | "      |                                  | Calcutta -                                 |                                |             |         | Bombay.                        |
| 63                | " "                 | "      |                                  | Bombay -                                   |                                |             |         | Madras.                        |
| 64                | " "                 | "      |                                  | Madras -                                   |                                |             |         | Bombay.                        |
| 65                | " "                 | "      |                                  | Bombay -                                   |                                |             |         | Calcutta.                      |
| 66                | " "                 | "      |                                  | Calcutta -                                 |                                |             |         | Madras.                        |
| 67                | " "                 | "      |                                  | Madras -                                   |                                |             |         | Do.                            |
| 68                | " "                 | "      |                                  | Do. -                                      |                                |             |         | Bombay.                        |
| 69                | " "                 | "      |                                  | Bombay -                                   |                                |             |         | Madras.                        |
| 70                | " "                 | "      |                                  | Madras -                                   |                                |             |         | Do.                            |
| 71                | " "                 | "      |                                  | Do. -                                      |                                |             |         | Do.                            |
| 72                | " "                 | "      |                                  | Do. -                                      |                                |             |         | Do.                            |
| 73                | " "                 | "      |                                  | Do. -                                      |                                |             |         | Do.                            |
| 74                | " "                 | "      |                                  | Bombay -                                   |                                |             |         | Bombay.                        |
| 75                | " "                 | "      |                                  | Do. -                                      |                                |             |         | Do.                            |
| 76                | " "                 | "      |                                  | Madras -                                   |                                |             |         | Madras.                        |
| 77                | " "                 | "      |                                  | O. S. Committee -                          |                                |             |         | Store.                         |
| 78                | " "                 | "      | 8 {                              | B. B., R.H.A. -                            |                                |             |         | Do.                            |
| 79                | " "                 | "      | 295 {                            | Shoeburyness -                             |                                |             |         | Tynemouth.                     |
| 80                | " "                 | "      |                                  | Tynemouth -                                |                                |             |         | Melbourne.                     |
| 81                | " "                 | "      |                                  | Melbourne -                                |                                |             |         | H.M.S. "Warrior."              |
| 82                | " "                 | "      |                                  | H.M.S. "Warrior" -                         |                                |             |         | " "Marlborough."               |
| 83                | " "                 | "      |                                  | " "Marlborough" -                          |                                |             |         | In Store.                      |
| 84                | " "                 | "      |                                  | Not issued -                               |                                |             |         | H.M.S. "Gibraltar."            |
| 85                | " "                 | "      |                                  | Chatham -                                  |                                |             |         | H.M.S. "Severn."               |
| 86                | " "                 | "      |                                  | Not issued -                               |                                |             |         | " "Marlborough."               |
| 87                | " "                 | "      |                                  | Chatham -                                  |                                |             |         |                                |
| 88                | " "                 | "      |                                  | Not issued -                               |                                |             |         |                                |
| 89                | " "                 | "      |                                  | Chatham -                                  |                                |             |         |                                |
| 90                | " "                 | "      |                                  | H.M.S. "Marlborough" -                     |                                |             |         |                                |
| 91                | " "                 | "      |                                  |                                            |                                |             |         |                                |
| 1                 | 20-pounder, L.S.    | E.O.C. |                                  | Canada -                                   |                                |             |         | Canada.                        |
| 6                 | " "                 | "      |                                  | Do. -                                      |                                |             |         | Do.                            |
| 10                | " "                 | "      |                                  | Do. -                                      |                                |             |         | Do.                            |
| 14                | " "                 | "      | 42 {                             | Shoeburyness -                             |                                |             |         | Store.                         |
| 16                | " "                 | "      |                                  |                                            |                                |             |         |                                |
| 17                | " "                 | "      |                                  | Canada -                                   |                                |             |         | Canada.                        |
| 18                | " "                 | "      |                                  | Do. -                                      |                                |             |         | Do.                            |
| 19                | " "                 | "      |                                  |                                            |                                |             |         |                                |
| 22                | " "                 | "      |                                  | Shoeburyness -                             |                                |             |         | Store.                         |
| 24                | " "                 | "      |                                  |                                            |                                |             |         |                                |
| 26                | " "                 | "      |                                  | Canada -                                   |                                |             |         | Canada.                        |
| 27                | " "                 | "      | 113 {                            | Shoeburyness -                             |                                |             |         | Store.                         |
|                   |                     |        |                                  | Do. -                                      |                                |             |         |                                |
|                   |                     |        |                                  | Do. -                                      |                                |             |         |                                |
| 221               | 20-pounder, S.S.    | E.O.C. | 347 {                            | Shoeburyness -                             |                                |             |         | Shoeburyness.                  |
|                   |                     |        |                                  | Do. -                                      |                                |             |         |                                |



Return of Armstrong Guns issued—*continued*.

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.        |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|-------------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair. |                         |
|                   |                |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                         |
| 1                 | 40-pounder -   | E. O. C. |                                  | Malta -                                    |                                |             |         | Malta.                  |
| 2                 | " -            | "        |                                  | Devonport -                                |                                |             |         | R. M., Devonport.       |
| 3                 | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Edgar."         |
| 4                 | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Revenge."            |
| 5                 | " -            | "        |                                  | Malta -                                    |                                |             |         | Malta.                  |
| 7                 | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Euryalus."      |
| 8                 | " -            | "        | 9                                | Do. -                                      |                                |             |         | " "Conqueror."          |
| 9                 | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Euryalus."           |
| 10                | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                |
| 11                | " -            | "        | 6                                | Do. -                                      |                                |             |         | H.M.S. "Phaeton."       |
| 12                | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Rattlesnake."        |
| 13                | " -            | "        |                                  | H.M.S. "Excellent" -                       |                                |             |         | " "Stork."              |
| 14                | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Edgar."              |
| 15                | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Marlborough."        |
| 16                | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Trafalgar."          |
| 17                | " -            | "        |                                  |                                            | +                              |             | 0 14 2½ | Store.                  |
| 18                | " -            | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Foudroyant."    |
| 19                | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Illustrious."        |
| 20                | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Icarus."             |
| 21                | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Foudroyant."         |
| 22                | " -            | "        |                                  | Do. -                                      |                                |             |         | " "                     |
| 23                | " -            | "        | 18                               | Portsmouth -                               |                                | 6 13 3      | 18 13 5 | " "Magicienne."         |
| 24                | " -            | "        | 401                              | Shoeburyness -                             |                                |             |         | } Shoeburyness.         |
| 25                | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Marlborough."   |
| 26                | " -            | "        |                                  | Malta -                                    |                                |             |         | Malta.                  |
| 27                | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                |
| 28                | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Marlborough."   |
| 29                | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Foudroyant."         |
| 30                | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Perseus."            |
| 31                | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Foudroyant."         |
| 32                | " -            | "        |                                  | Do. -                                      |                                |             |         | " "                     |
| 33                | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Marlborough."        |
| 34                | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Tribune."            |
| 35                | " -            | "        | 501                              | Shoeburyness -                             |                                | 27 4 1      | 0 2 3   | Store.                  |
| 36                | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Edgar."         |
| 37                | " -            | "        | 9                                | Devonport -                                |                                |             |         | " "Conqueror."          |
| 38                | " -            | "        |                                  | Chatham -                                  |                                |             |         | " "Barossa."            |
| 40                | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Euryalus."           |
| 41                | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.G.B. "Bullfrog."    |
| 42                | " -            | "        |                                  | Do. -                                      |                                |             |         | Chatham.                |
| 43                | " -            | "        |                                  | Portsmouth -                               |                                | 5 10 8      |         | H.M.S. "Shannon."       |
| 44                | " -            | "        | 776                              | O.S. Committee -                           |                                |             |         | } Store.                |
| 45                | " -            | "        |                                  | Shoeburyness -                             |                                |             |         | H.M.S. "Euryalus."      |
| 46                | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Tribune."            |
| 47                | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Revenge."            |
| 48                | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Excellent."          |
| 49                | " -            | "        |                                  | R. Mar., Woolwich -                        |                                |             |         | R. Mar., Woolwich.      |
| 50                | " -            | "        |                                  | Malta -                                    |                                |             |         | H.M.S. "Hannibal."      |
| 51                | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Trinculo."           |
| 52                | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Euryalus."           |
| 53                | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Trafalgar."          |
| 54                | " -            | "        |                                  | Malta -                                    |                                |             |         | " "Perseus."            |
| 55                | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Shannon."            |
| 56                | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Immortalité."        |
| 57                | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Cambridge."          |
| 58                | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Marlborough."        |
| 59                | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Edgar."              |
| 60                | " -            | "        |                                  | Chatham -                                  |                                |             |         | " "Barossa."            |
| 61                | " -            | "        |                                  | Do. -                                      |                                |             |         | H.M.G.B. "Rattler."     |
| 62                | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Trafalgar."     |
| 63                | " -            | "        |                                  | Malta -                                    |                                |             |         | " "Perseus."            |
| 64                | " -            | "        |                                  | Do. -                                      |                                |             |         | Malta.                  |
| 65                | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Tribune."       |
| 66                | " -            | "        |                                  | Do. -                                      |                                |             |         | H.M.G.B. "Amelia."      |
| 67                | " -            | "        | 10                               | Do. -                                      |                                |             |         | H.M.S. "Conqueror."     |
| 68                | " -            | "        | 26                               | O.S. Committee -                           |                                | 3 15 7      | 80 10 0 | } Do.                   |
| 69                | " -            | "        |                                  | Shoeburyness -                             |                                |             |         | H.M.G.B. "Raven."       |
| 70                | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Magicienne."    |
| 71                | " -            | "        | 26                               | Portsmouth -                               |                                |             |         | " "Rattlesnake."        |
| 72                | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Trafalgar."          |
| 73                | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Hannibal."           |
| 74                | " -            | "        |                                  | Chatham -                                  |                                |             |         | " "Conqueror."          |
| 75                | " -            | "        |                                  | Malta -                                    |                                |             |         | " "Hannibal."           |
| 76                | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Trafalgar."          |
| 77                | " -            | "        | 21                               | H.M.S. "Trusty" -                          |                                | 8 9 0       |         | } "Investigator"        |
|                   |                |          |                                  | O. S. Committee -                          |                                |             |         |                         |
|                   |                |          |                                  | H.M.S. "Investigator" -                    |                                |             |         |                         |
| 78                | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.G.B. "Rattler."     |
| 79                | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Spider."             |
| 80                | " -            | "        | 19                               | Portsmouth -                               |                                |             |         | H.M.S. "Euryalus."      |
| 81                | " -            | "        |                                  | Do. -                                      |                                |             |         | H.M.G.B. "High-lander." |
| 82                | " -            | "        | 6                                | Do. -                                      |                                |             |         | H.M.S. "St. George."    |

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |          | Present Station.           |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|----------|----------------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair.  |                            |
| 83                | 40-pounder -   | E. O. C. |                                  | Portsmouth -                               |                                | £ s. d.     | £ s. d.  | H.M.S. "Tribune."          |
| 84                | " -            | "        |                                  | Do. -                                      |                                | 3 15 7      | 10 10 6  | " " "Satellite."           |
| 85                | " -            | "        |                                  | Devonport -                                |                                |             |          | " " "Trafalgar."           |
| 87                | " -            | "        | 173                              | Portsmouth -                               |                                | 3 18 7      | 48 14 6  | " " "Shoeburyness."        |
| 88                | " -            | "        |                                  | Shoeburyness -                             |                                |             |          | H.M.S. "Emerald."          |
| 89                | " -            | "        |                                  | Do. -                                      |                                |             |          | Commandant.                |
| 90                | " -            | "        |                                  | Devonport -                                |                                | 3 15 7      | 10 10 6  | H.M.S. "Rifleman."         |
| 91                | " -            | "        | 195                              | Commandant -                               |                                | 17 16 0     | - - -    | " " "Rifleman."            |
| 92                | " -            | "        |                                  | H.M.S. "Rifleman"                          |                                |             |          | Store.                     |
| 93                | " -            | "        |                                  | " " "Trusty"                               |                                |             |          | Fort Cumberland.           |
| 94                | " -            | "        | 50                               | O. S. Committee                            |                                |             |          | H.M.S. "Conqueror."        |
| 95                | " -            | "        |                                  | Portsmouth -                               |                                | 3 15 7      | 10 10 6  | Do.                        |
| 96                | " -            | "        | 6                                | Devonport -                                |                                | 3 15 7      | 10 10 6  | H.M.S. "Satellite."        |
| 97                | " -            | "        |                                  | Do. -                                      |                                |             |          | " " "Petrel."              |
| 98                | " -            | "        |                                  | H.M.S. "Narcissus"                         |                                |             |          | " " "Narcissus."           |
| 99                | " -            | "        |                                  | Devonport -                                |                                |             |          | " " "Rattlesnake."         |
| 100               | " -            | "        |                                  | Do. -                                      |                                |             |          | " " "Satellite."           |
| 101               | " -            | "        | 631                              | Shoeburyness                               |                                | 32 4 8      | 5 11 9   | Store.                     |
| 102               | " -            | "        | 143                              | Portsmouth -                               |                                |             |          | H.M.S. "Shannon."          |
| 103               | " -            | "        |                                  | Devonport -                                |                                | - - -       | 11 3 7   | H.M.G.B. "Sheld-<br>rake." |
| 104               | " -            | "        |                                  | Do. -                                      |                                |             |          | H.M.S. "Aboukir."          |
| 105               | " -            | "        |                                  | Do. -                                      |                                |             |          | Do.                        |
| 106               | " -            | "        |                                  | Do. -                                      |                                |             |          | Do.                        |
| 107               | " -            | "        |                                  | Devonport -                                | R.                             | - - -       | 12 6 0   | Commandant.                |
| 108               | " -            | "        |                                  | Commandant -                               |                                |             |          | H.M.S. "Trafalgar."        |
| 109               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | " " "Tribune."             |
| 110               | " -            | "        |                                  | Do. -                                      |                                |             |          | Roy. Mar., Gosport.        |
| 111               | " -            | "        |                                  | Devonport -                                |                                |             |          | H.M.S. "Conqueror."        |
| 112               | " -            | "        |                                  | Do. -                                      |                                |             |          | " " "Aboukir."             |
| 113               | " -            | "        | 13                               | Malta -                                    | R.                             |             |          | Devonport.                 |
| 114               | " -            | "        |                                  | Devonport -                                |                                |             |          | H.M.S. "Aboukir."          |
| 115               | " -            | "        |                                  | Chatham -                                  |                                |             |          | " " "Conqueror."           |
| 116               | " -            | "        |                                  | Devonport -                                |                                |             |          | " " "Pantaloons."          |
| 117               | " -            | "        | 23                               | Portsmouth -                               |                                |             |          | " " "Magicienne."          |
| 118               | " -            | "        | 17                               | Malta -                                    |                                |             |          | Devonport.                 |
| 119               | " -            | "        |                                  | Devonport -                                |                                |             |          | H.M.S. "Conqueror."        |
| 120               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | " " "Rinaldo."             |
| 121               | " -            | "        |                                  | Chatham -                                  |                                |             |          | H.M.G.B. "Rattler."        |
| 122               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | H.M.S. "Trafalgar."        |
| 123               | " -            | "        |                                  | Devonport -                                |                                |             |          | H.M.G.B. "Charon."         |
| 124               | " -            | "        | 59                               | H.M.S. "Rapid"                             |                                |             |          | H.M.S. "Rapid."            |
| 125               | " -            | "        |                                  | Malta -                                    |                                |             |          | Malta.                     |
| 126               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | H.M.S. "Chanticleer."      |
| 127               | " -            | "        |                                  | Do. -                                      |                                |             |          | Portsmouth.                |
| 128               | " -            | "        | 6                                | Devonport -                                |                                | 0 12 6      | 55 12 7  | H.M.S. "Conqueror."        |
| 129               | " -            | "        |                                  | O. S. Committee                            | +                              |             |          | Store.                     |
| 130               | " -            | "        |                                  | Malta -                                    |                                |             |          | Malta.                     |
| 131               | " -            | "        | 29                               | Do. -                                      |                                | - - -       | 12 5 7   | Store.                     |
| 132               | " -            | "        |                                  | Chatham -                                  |                                |             |          | H.M.G.B. "Rattler."        |
| 133               | " -            | "        |                                  | Devonport -                                |                                |             |          | H.M.S. "Emerald."          |
| 134               | " -            | "        | 30                               | Malta -                                    |                                |             |          | H.M.G.B. "Alert."          |
| 135               | " -            | "        |                                  | Fort Cumberland                            |                                |             |          | Fort Cumberland.           |
| 136               | " -            | "        | 145                              | Shoeburyness                               |                                | - - -       | 12 18 3  | Store, short.              |
| 137               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | H.M.S. "Edgar."            |
| 138               | " -            | "        |                                  | Malta -                                    |                                |             |          | Malta.                     |
| 139               | " -            | "        |                                  | Royl. Mar., Woolwich                       |                                |             |          | Royl. Mar. Woolwich.       |
| 140               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | H.M.S. "Illustrious."      |
| 141               | " -            | "        |                                  | Devonport -                                |                                |             |          | " " "Aboukir."             |
| 143               | " -            | "        |                                  | H.M.S. "Narcissus"                         |                                |             |          | " " "Narcissus."           |
| 144               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | " " "Excellent."           |
| 145               | " -            | "        |                                  | Do. -                                      |                                |             |          | " " "Marlbrough."          |
| 146               | " -            | "        |                                  | Devonport -                                |                                |             |          | " " "Rattlesnake."         |
| 147               | " -            | "        | 369                              | Proving V. pieces                          | +                              | - - -       | 53 17 8½ | Store.                     |
| 148               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | H.M.S. "Illustrious."      |
| 149               | " -            | "        |                                  | Do. -                                      |                                |             |          | " " " "                    |
| 150               | " -            | "        |                                  | Chatham -                                  |                                |             |          | " " "Cameleon."            |
| 151               | " -            | "        |                                  | Portsmouth -                               |                                | 36 10 7     | 13 3 4   | Rl. Mar., Woolwich.        |
| 152               | " -            | "        |                                  | Malta -                                    |                                |             |          | H.M.S. "Hannibal."         |
| 154               | " -            | "        |                                  | Devonport -                                |                                |             |          | " " "Conqueror."           |
| 155               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | " " "Illustrious."         |
| 156               | " -            | "        | 42                               | Devonport -                                |                                |             |          | " " "Greyhound."           |
| 157               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | " " "Edgar."               |
| 158               | " -            | "        |                                  | Devonport -                                |                                |             |          | " " "Foudroyant."          |
| 159               | " -            | "        |                                  | Malta -                                    |                                | 30 4 4      | 5 14 3   | Store.                     |
| 160               | " -            | "        |                                  | Devonport -                                |                                |             |          | H.M.S. "Foudroyant."       |
| 161               | " -            | "        |                                  | Malta -                                    |                                |             |          | Malta.                     |
| 162               | " -            | "        |                                  | Do. -                                      |                                |             |          | Do.                        |
| 163               | " -            | "        |                                  | Westley Richards                           |                                |             |          | Store.                     |



## Return of Armstrong Guns issued—continued.

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |          | Present Station.         |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|----------|--------------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair.  |                          |
|                   |                |          |                                  |                                            |                                | £ s. d.     | £ s. d.  |                          |
| 164               | 40-pounder -   | E. O. C. |                                  | Portsmouth -                               |                                |             |          | H.M.S. "Princess Royal." |
| 165               | " -            | "        |                                  | Do. -                                      |                                |             |          | " "Pelican."             |
| 166               | " -            | "        | 1,050                            | Proving V. pieces -                        | +                              | - - -       | 72 12 0½ | Store.                   |
| 167               | " -            | "        | 671                              | Portsmouth -                               |                                | 31 10 5     | 22 10 11 | Rl. Mar., Woolwich.      |
| 168               | " -            | "        |                                  | Chatham -                                  |                                |             |          | H.M.G.B. "Griper."       |
| 169               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | H.M.S. "Shannon."        |
| 170               | " -            | "        |                                  | Chatham -                                  |                                |             |          | " "Barossa."             |
| 171               | " -            | "        |                                  | Do. -                                      |                                |             |          | " "Shannon."             |
| 172               | " -            | "        |                                  | Portsmouth -                               | R.                             |             |          | Proving V. pieces.       |
| 173               | " -            | "        | 172                              | Proving V. pieces -                        |                                |             |          | H.M.S. "Shannon."        |
| 174               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | Rl. Marines, Chatham.    |
| 175               | " -            | "        |                                  | Chatham -                                  |                                |             |          | H.M.S. "Tribune."        |
| 176               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | " "Erne."                |
| 178               | " -            | "        |                                  | Chatham -                                  |                                |             |          | " "Conqueror."           |
| 179               | " -            | "        |                                  | Devonport -                                |                                |             |          | " "Marlborough."         |
| 180               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | Malta.                   |
| 181               | " -            | "        |                                  | Malta -                                    |                                |             |          | Store.                   |
| 182               | " -            | "        | 1                                | Shoeburyness -                             |                                |             |          |                          |
| 183               | " -            | "        |                                  |                                            |                                |             |          |                          |
| 184               | " -            | "        | 144                              | Proving V. pieces -                        | +                              | - - -       | 78 11 2½ | Store.                   |
| 186               | " -            | "        |                                  | H.M.S. "Warrior" -                         |                                |             |          | H.M.S. "Warrior."        |
| 187               | " -            | "        |                                  | Chatham -                                  |                                |             |          | " "Rosario."             |
| 189               | " -            | "        |                                  | Do. -                                      |                                |             |          | H.M.G.B. "Julia."        |
| 190               | " -            | "        | 6                                | Portsmouth -                               |                                |             |          | H.M.S. "Conqueror."      |
| 191               | " -            | "        | 721                              | Shoeburyness -                             |                                | - - -       | 12 5 7   | Loan, Rl. Laboratory.    |
| 192               | " -            | "        |                                  | Chatham -                                  |                                |             |          | Rl. Marines, Chatham.    |
| 193               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | Portsmouth.              |
| 194               | " -            | "        |                                  | Devonport -                                |                                |             |          | H.M.S. "Conqueror."      |
| 195               | " -            | "        | 244                              | Portsmouth -                               | +                              | 28 10 10    | 56 3 0½  | Store.                   |
| 196               | " -            | "        | 16                               | Chatham -                                  |                                |             |          | H.M.S. "Phaeton."        |
| 197               | " -            | "        |                                  | Do. -                                      |                                |             |          | " "Zebra."               |
| 198               | " -            | "        | 72                               | Do. -                                      |                                |             |          | H.M.G.B. "Ruby."         |
| 199               | " -            | "        |                                  | Devonport -                                |                                |             |          | Royal Marines.           |
| 200               | " -            | "        | 26                               | Portsmouth -                               |                                |             |          | H.M.S. "Magicienne."     |
| 201               | " -            | "        |                                  | Devonport -                                |                                |             |          | " "Perseus."             |
| 202               | " -            | "        |                                  | H.M.S. "Warrior" -                         |                                |             |          | " "Warrior."             |
| 203               | " -            | "        |                                  | Chatham -                                  |                                |             |          | " "Britomart."           |
| 204               | " -            | "        |                                  | H.M.S. "Warrior" -                         |                                |             |          | " "Warrior."             |
| 205               | " -            | "        |                                  | Do. -                                      |                                |             |          |                          |
| 206               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | R.M., Gosport.           |
| 207               | " -            | "        |                                  | Malta -                                    |                                |             |          | Malta.                   |
| 208               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | H.M.S. "St. George."     |
| 209               | " -            | "        |                                  | Do. -                                      |                                |             |          | H.M.G.B. "Blazer."       |
| 210               | " -            | "        |                                  | Do. -                                      |                                |             |          | Royal Marines.           |
| 211               | " -            | "        |                                  | Do. -                                      |                                |             |          | H.M.S. "Princess Royal." |
| 212               | " -            | "        |                                  | Do. -                                      |                                |             |          | H.M.G.B. "Rose."         |
| 213               | " -            | "        |                                  | H.M.S. "Doteril" -                         |                                |             |          | H.M.S. "Doteril."        |
| 214               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | H.M.G.B. "Escort."       |
| 215               | " -            | "        |                                  | Devonport -                                |                                |             |          | H.M.S. "Satellite."      |
| 216               | " -            | "        |                                  | Do. -                                      |                                |             |          | " "Trafalgar."           |
| 217               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | " "Marlborough."         |
| 218               | " -            | "        |                                  | Do. -                                      |                                |             |          | " "Immortalité."         |
| 219               | " -            | "        |                                  | Devonport -                                |                                |             |          | Devonport.               |
| 220               | " -            | "        |                                  | H.M.S. "Cambridge."                        |                                |             |          | H.M.G.B. "Rattler."      |
|                   |                |          |                                  | Chatham -                                  |                                |             |          |                          |
| 221               | " -            | "        | 137                              | Shoeburyness -                             |                                | 18 9 10     | 22 12 0  | Shoeburyness.            |
|                   |                |          |                                  | Do. -                                      |                                |             |          |                          |
| 222               | " -            | "        |                                  | Do. -                                      |                                |             |          |                          |
| 223               | " -            | "        | 18                               | Devonport -                                |                                |             |          | H.M.S. "Perseus."        |
| 224               | " -            | "        | 17                               | Shoeburyness -                             |                                |             |          | Shoeburyness.            |
| 225               | " -            | "        |                                  | Do. -                                      |                                | 2 18 2      | 49 5 0   | Store.                   |
| 226               | " -            | "        |                                  | Chatham -                                  |                                |             |          | Chatham.                 |
| 227               | " -            | "        |                                  | Do. -                                      |                                |             |          | Do.                      |
| 228               | " -            | "        |                                  | Portsmouth -                               |                                |             |          | H.M.S. "Edgar."          |
| 229               | " -            | "        |                                  | Devonport -                                |                                |             |          | Devonport.               |
| 230               | " -            | "        |                                  | Do. -                                      |                                |             |          | Do.                      |
| 231               | " -            | "        |                                  | Chatham -                                  |                                |             |          | Chatham.                 |
| 232               | " -            | "        |                                  | Do. -                                      |                                |             |          | Do.                      |
| 233               | " -            | "        |                                  | Do. -                                      |                                |             |          | Do.                      |
| 234               | " -            | "        |                                  | Do. -                                      |                                |             |          | Do.                      |
| 235               | " -            | "        |                                  | Do. -                                      |                                |             |          | Do.                      |
| 236               | " -            | "        |                                  | New Brunswick                              |                                |             |          | New Brunswick.           |
| 237               | " -            | "        | 431                              | Shoeburyness -                             |                                |             |          | Shoeburyness.            |
| 238               | " -            | "        |                                  | Devonport -                                |                                |             |          | H.M.S. "Severn."         |
| 239               | " -            | "        |                                  | New Brunswick                              |                                |             |          | New Brunswick.           |
| 240               | " -            | "        |                                  | Do. -                                      |                                |             |          | Do.                      |
| 241               | " -            | "        |                                  | Devonport -                                |                                |             |          | H.M.S. "Liffey."         |
| 242               | " -            | "        |                                  | Do. -                                      |                                |             |          | " "Princess Royal."      |
| 243               | " -            | "        |                                  | Do. -                                      |                                |             |          | " "Severn."              |
| 244               | " -            | "        |                                  | Chatham -                                  |                                |             |          | " "Raccoon."             |
| 245               | " -            | "        |                                  | Do. -                                      |                                |             |          | Chatham.                 |
| 246               | " -            | "        |                                  | Cape -                                     |                                |             |          | Cape.                    |
| 247               | " -            | "        |                                  | New Brunswick                              |                                |             |          | New Brunswick.           |

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.            |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|-----------------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair. |                             |
|                   |                |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                             |
| 248               | 40-pounder -   | E. O. C. |                                  | New Brunswick                              | -                              |             |         | New Brunswick.              |
| 249               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Leander."           |
| 250               | " -            | "        |                                  | Devonport -                                | -                              |             |         | " "Liverpool."              |
| 251               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Gibraltar."              |
| 252               | " -            | "        |                                  | New Brunswick                              | -                              |             |         | New Brunswick.              |
| 253               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Cossack."           |
| 254               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                  |
| 255               | " -            | "        |                                  | New Brunswick                              | -                              |             |         | New Brunswick.              |
| 256               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                  |
| 257               | " -            | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Severn."            |
| 258               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | " "Shannon."                |
| 259               | " -            | "        |                                  | Devonport -                                | -                              |             |         | " "Gibraltar."              |
| 260               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Leopard."                |
| 261               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Devonport.                  |
| 262               | " -            | "        |                                  | New Brunswick                              | -                              |             |         | New Brunswick.              |
| 263               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Raccoon."           |
| 264               | " -            | "        |                                  | Devonport -                                | -                              |             |         | " "Gibraltar."              |
| 266               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Devonport.                  |
| 267               | " -            | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Liffey."            |
| 268               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | " "Meanee."                 |
| 269               | " -            | "        |                                  | Newfoundland                               | -                              |             |         | Newfoundland.               |
| 270               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                  |
| 271               | " -            | "        |                                  | No. 4 Battery                              | -                              |             |         | No. 4 Battery.              |
| 272               | " -            | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Phoebe."            |
| 273               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Gibraltar."              |
| 274               | " -            | "        |                                  | Newfoundland                               | -                              |             |         | Newfoundland.               |
| 275               | " -            | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Leopard."           |
| 276               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Princess<br>Royal."      |
| 277               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Severn."                 |
| 278               | " -            | "        |                                  | Newfoundland                               | -                              |             |         | Newfoundland.               |
| 279               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 280               | " -            | "        |                                  | Newfoundland                               | -                              |             |         | Newfoundland.               |
| 281               | " -            | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Liverpool."         |
| 282               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Phoebe."                 |
| 283               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 284               | " -            | "        |                                  | Devonport -                                | -                              |             |         | H.M.G.B. "Clinker."         |
| 285               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Devonport.                  |
| 286               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 287               | " -            | "        |                                  | No. 15 Battery                             | -                              |             |         | No. 15 Battery.             |
| 288               | " -            | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Phoebe."            |
| 289               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         |                             |
| 290               | " -            | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Princess<br>Royal." |
| 291               | " -            | "        | 10                               | Shoeburyness                               | -                              |             |         | Shoeburyness.               |
| 292               | " -            | "        | "                                | Devonport -                                | -                              |             |         | H.M.S. "Phoebe."            |
| 293               | " -            | "        | "                                | Chatham -                                  | -                              |             |         | Chatham.                    |
| 294               | " -            | "        | "                                | Devonport -                                | -                              |             |         | H.M.S. "Severn."            |
| 295               | " -            | "        | "                                | Do. -                                      | -                              |             |         | " "Leopard."                |
| 296               | " -            | "        | "                                | Chatham -                                  | -                              |             |         | Chatham.                    |
| 297               | " -            | "        | 36                               | Do. -                                      | -                              |             |         | Do.                         |
| 298               | " -            | "        | "                                | Devonport -                                | -                              |             |         | H.M.S. "Liffey."            |
| 299               | " -            | "        | "                                | Chatham -                                  | -                              |             |         | " "Raccoon."                |
| 300               | " -            | "        | "                                | Devonport -                                | -                              |             |         | Devonport.                  |
| 301               | " -            | "        | "                                | No. 20 Battery                             | -                              |             |         | No. 20 Battery.             |
| 302               | " -            | "        | "                                | Portsmouth -                               | -                              |             |         | H.M.S. "Sutlej."            |
| 303               | " -            | "        | "                                | Do. -                                      | -                              |             |         | " "Duncan."                 |
| 304               | " -            | "        | "                                | Do. -                                      | -                              |             |         | " "Edgar."                  |
| 305               | " -            | "        | "                                | Devonport -                                | -                              |             |         | Devonport.                  |
| 306               | " -            | "        | "                                | No. 1 Battery                              | -                              |             |         | No. 1 Battery.              |
| 307               | " -            | "        | "                                | Chatham -                                  | -                              |             |         | H.M.S. "Leander."           |
| 308               | " -            | "        | 10                               | H.M.S. "Melpomene"                         | -                              |             |         | " "Melpomene."              |
| 309               | " -            | "        | "                                | Portsmouth -                               | -                              |             |         | " "Curaçoa."                |
| 310               | " -            | "        | "                                | Chatham -                                  | -                              |             |         | Chatham.                    |
| 311               | " -            | "        | "                                | H.M.S. "Excellent"                         | -                              |             |         | H.M.S. "Excellent."         |
| 312               | " -            | "        | "                                | Devonport -                                | -                              |             |         | Devonport.                  |
| 313               | " -            | "        | "                                | Chatham -                                  | -                              |             |         | H.M.S. "Cossack."           |
| 314               | " -            | "        | "                                | Do. -                                      | -                              |             |         | " "Pylades."                |
| 315               | " -            | "        | "                                | Devonport -                                | -                              |             |         | " "Gibraltar."              |
| 316               | " -            | "        | "                                | Portsmouth -                               | -                              |             |         | " "Emerald."                |
| 317               | " -            | "        | "                                | Devonport -                                | -                              |             |         | Devonport.                  |
| 318               | " -            | "        | "                                | Portsmouth -                               | -                              |             |         | H.M.S. "Duncan."            |
| 319               | " -            | "        | "                                | Chatham -                                  | -                              |             |         | " "Leander."                |
| 320               | " -            | "        | "                                | Devonport -                                | -                              |             |         | Devonport.                  |
| 321               | " -            | "        | "                                | Portsmouth -                               | -                              |             |         | H.M.S. "Duncan."            |
| 322               | " -            | "        | "                                | Chatham -                                  | -                              |             |         | Chatham.                    |
| 323               | " -            | "        | "                                | Do. -                                      | -                              |             |         | Do.                         |
| 324               | " -            | "        | "                                | Royal Mar., Plymouth                       | -                              |             |         | Royal Mar., Plymouth.       |
| 325               | " -            | "        | "                                | Chatham -                                  | -                              |             |         | Chatham.                    |
| 326               | " -            | "        | "                                | H.M.S. "Immortalité"                       | -                              |             |         | H.M.S. "Immortalité."       |
| 327               | " -            | "        | "                                | Portsmouth -                               | -                              |             |         | " "Esk."                    |
| 328               | " -            | "        | "                                | Devonport -                                | -                              |             |         | " "Severn."                 |
| 329               | " -            | "        | "                                | Do. -                                      | -                              |             |         | " "Gibraltar."              |
| 331               | " -            | "        | "                                | Portsmouth -                               | -                              |             |         | " "Sutlej."                 |
| 332               | " -            | "        | "                                | H.M.S. "Melpomene"                         | -                              |             |         | " "Phaeton."                |
| 333               | " -            | "        | "                                | No. 2 Battery                              | -                              |             |         | No. 2 Battery.              |
| 334               | " -            | "        | 137                              | Fort Cumberland                            | -                              | 2 4 0       |         | Store.                      |



Return of Armstrong Guns issued—*continued.*

| No.<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.       |
|-------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|------------------------|
|             |                |          |                                  |                                            |                                | Alteration. | Repair. |                        |
|             |                |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                        |
| 335         | 40-pounder -   | E. O. C. |                                  | H.M.S. "Melpomene"                         |                                |             |         | H.M.S. "Phaeton."      |
| 336         | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 337         | " -            | "        |                                  | Do. -                                      |                                |             |         | Do.                    |
| 338         | " -            | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Gibraltar."    |
| 339         | " -            | "        |                                  | Do. -                                      |                                |             |         | Devonport.             |
| 340         | " -            | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Gibraltar."    |
| 341         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Edgar."             |
| 342         | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Princess<br>Royal." |
| 343         | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Gibraltar."         |
| 344         | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Phoebe."            |
| 345         | " -            | "        |                                  | Fort Cumberland -                          |                                |             |         | Fort Cumberland.       |
| 346         | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 347         | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 348         | " -            | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Severn."       |
| 349         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Emerald."           |
| 350         | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Phoebe."            |
| 351         | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 352         | " -            | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Liffey."       |
| 353         | " -            | "        | 268                              | Shoeburyness                               |                                |             |         | Shoeburyness.          |
| 354         | " -            | "        | 40                               | No. 1 Battery                              |                                |             |         | No. 1 Battery.         |
| 355         | " -            | "        |                                  | No. 11 "                                   |                                |             |         | No. 11                 |
| 356         | " -            | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Gibraltar."    |
| 357         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Edgar."             |
| 358         | " -            | "        |                                  | H.M.S. "Immortalité"                       |                                |             |         | " "Immortalité."       |
| 359         | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Liffey."            |
| 360         | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Phoebe."            |
| 361         | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 362         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Curaçoa."      |
| 363         | " -            | "        | 55                               | Shoeburyness                               |                                |             |         | Shoeburyness.          |
| 364         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Sutlej."       |
| 366         | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 367         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Edgar."        |
| 368         | " -            | "        |                                  | Chatham -                                  |                                |             |         | " "Leander."           |
| 369         | " -            | "        |                                  | H.M.S. "Melpomene"                         |                                |             |         | " "Phaeton."           |
| 370         | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Gibraltar."         |
| 371         | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Severn."            |
| 372         | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Liffey."            |
| 373         | " -            | "        |                                  | Fort Cumberland                            |                                |             |         | Fort Cumberland.       |
| 374         | " -            | "        | 10                               | H.M.S. "Melpomene"                         |                                |             |         | H.M.S. "Phaeton."      |
| 375         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Foam."              |
| 376         | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 377         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Black Prince." |
| 378         | " -            | "        |                                  | Chatham -                                  |                                |             |         | " "Meanee."            |
| 379         | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Princess<br>Royal." |
| 380         | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Liffey."            |
| 381         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Sutlej."            |
| 382         | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 383         | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 384         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Revenge."      |
| 386         | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Gibraltar."         |
| 387         | " -            | "        |                                  | Chatham -                                  |                                |             |         | " "Leander."           |
| 388         | " -            | "        |                                  | Do. -                                      |                                |             |         | Chatham.               |
| 389         | " -            | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Delight."      |
| 390         | " -            | "        |                                  | Do. -                                      |                                |             |         | Devonport.             |
| 391         | " -            | "        |                                  | H.M.S. "Immortalité"                       |                                |             |         | H.M.S. "Immortalité"   |
| 392         | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Liffey."            |
| 393         | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.               |
| 394         | " -            | "        |                                  | Do. -                                      |                                |             |         | H.M.S. "Meanee."       |
| 395         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.G.B. "Fancy."      |
| 396         | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.             |
| 397         | " -            | "        |                                  | H.M.S. "Immortalité"                       |                                |             |         | H.M.S. "Immortalité"   |
| 398         | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Edgar."             |
| 399         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | Devonport.             |
| 400         | " -            | "        |                                  | Devonport -                                |                                |             |         | Chatham.               |
| 401         | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Immortalité"   |
| 402         | " -            | "        |                                  | H.M.S. "Immortalité"                       |                                |             |         | " "Shannon."           |
| 403         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Liverpool."         |
| 404         | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Revenge."           |
| 405         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Excellent."         |
| 406         | " -            | "        |                                  | H.M.S. "Excellent"                         |                                |             |         | " "Black Prince."      |
| 407         | " -            | "        |                                  | Do. -                                      |                                |             |         | " "                    |
| 408         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | Halifax.               |
| 409         | " -            | "        |                                  | Halifax -                                  |                                |             |         | H.M.S. "Phoebe."       |
| 410         | " -            | "        |                                  | Devonport -                                |                                |             |         | " "Sutlej."            |
| 411         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | No. 14 Battery.        |
| 412         | " -            | "        |                                  | No. 14 Battery                             |                                |             |         | H.M.S. "Revenge."      |
| 413         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | No. 7 Battery.         |
| 414         | " -            | "        |                                  | No. 7 Battery                              |                                |             |         | H.M.S. "Leander."      |
| 415         | " -            | "        |                                  | Chatham -                                  |                                |             |         | No. 2 Battery.         |
| 416         | " -            | "        |                                  | No. 2 Battery                              |                                |             |         | Chatham.               |
| 417         | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Duncan."       |
| 418         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Cossack."           |
| 419         | " -            | "        |                                  | Chatham -                                  |                                |             |         | " "Emerald."           |
| 420         | " -            | "        |                                  | Portsmouth -                               |                                |             |         | " "Duncan."            |
| 421         | " -            | "        |                                  | Do. -                                      |                                |             |         | " "                    |

Return of Armstrong Guns issued—*continued*.

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.            |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|-----------------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair. |                             |
|                   |                |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                             |
| 422               | 40-pounder -   | E. O. C. | 11                               | Chatham -                                  | -                              |             |         | H.M.S. "Leander."           |
| 423               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | " "Black-Prince."           |
| 424               | " -            | "        |                                  | Fort Cumberland                            | -                              |             |         | Fort Cumberland.            |
| 425               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Black-Prince."      |
| 426               | " -            | "        |                                  | No. 6 Battery                              | -                              |             |         | No. 6 Battery.              |
| 427               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Revenge."           |
| 428               | " -            | "        |                                  | Devonport -                                | -                              |             |         | " "Liverpool."              |
| 429               | " -            | "        |                                  | No. 10 Battery                             | -                              |             |         | No. 10 Battery.             |
| 430               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Duncan."            |
| 431               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Revenge."                |
| 432               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "                         |
| 433               | " -            | "        |                                  | Devonport -                                | -                              |             |         | " "Princess<br>Royal."      |
| 434               | " -            | "        | 10                               | Chatham -                                  | -                              |             |         | Chatham.                    |
| 435               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Edgar."             |
| 436               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Revenge."                |
| 437               | " -            | "        |                                  | No. 2 Battery                              | -                              |             |         | No. 2 Battery.              |
| 438               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Meanee."            |
| 439               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                  |
| 440               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Revenge."           |
| 441               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Duncan."                 |
| 442               | " -            | "        |                                  | Cape                                       | -                              |             |         | Cape.                       |
| 443               | " -            | "        |                                  | No. 10 Battery                             | -                              |             |         | No. 10 Battery.             |
| 444               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Meanee."            |
| 445               | " -            | "        | 8                                | Portsmouth -                               | -                              |             |         | " "Sutlej."                 |
| 446               | " -            | "        |                                  | H.M.S. "Excellent"                         | -                              |             |         | " "Excellent."              |
| 447               | " -            | "        |                                  | No. 2 Battery                              | -                              |             |         | No. 2 Battery.              |
| 448               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Meanee."            |
| 449               | " -            | "        |                                  | No. 4 Battery                              | -                              |             |         | No. 4 Battery.              |
| 450               | " -            | "        |                                  | H.M.S. "Melpomene"                         | -                              |             |         | H.M.S. "Phaeton."           |
| 451               | " -            | "        |                                  | No. 8 Battery                              | -                              |             |         | No. 8 Battery.              |
| 452               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 453               | " -            | "        |                                  | H.M.S. "Excellent"                         | -                              |             |         | H.M.S. "Excellent."         |
| 454               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | " "Duncan."                 |
| 455               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                  |
| 456               | " -            | "        | 40                               | Portsmouth -                               | -                              |             |         | H.M.S. "Duncan."            |
| 457               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | " "Pylades."                |
| 458               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | " "Edgar."                  |
| 459               | " -            | "        |                                  | H.M.S. "Excellent"                         | -                              |             |         | " "Excellent."              |
| 460               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | " "Duncan."                 |
| 461               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Edgar."                  |
| 462               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 463               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Curaçoa."           |
| 464               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Sutlej."                 |
| 465               | " -            | "        |                                  | No. 3 Battery                              | -                              |             |         | No. 3 Battery.              |
| 466               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | Portsmouth.                 |
| 467               | " -            | "        | 7                                | Do. -                                      | -                              |             |         | H.M.S. "Sutlej."            |
| 468               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Emerald."                |
| 469               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | " "Meanee."                 |
| 470               | " -            | "        |                                  | No. 3 Battery                              | -                              |             |         | No. 3 Battery.              |
| 471               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Edgar."             |
| 472               | " -            | "        |                                  | Devonport -                                | -                              |             |         | " "Leopard."                |
| 473               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 474               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                  |
| 475               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 476               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | H.M.S. "Duncan."            |
| 477               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Curaçoa."                |
| 478               | " -            | "        | 40                               | Chatham -                                  | -                              |             |         | " "Leander."                |
| 479               | " -            | "        |                                  | No. 3 Battery                              | -                              |             |         | No. 3 Battery.              |
| 480               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Meanee."            |
| 481               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                  |
| 482               | " -            | "        |                                  | No. 5 Battery                              | -                              |             |         | No. 5 Battery.              |
| 483               | " -            | "        |                                  | " 1 "                                      | -                              |             |         | " 1 "                       |
| 484               | " -            | "        |                                  | " 3 "                                      | -                              |             |         | " 3 "                       |
| 485               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | Chatham.                    |
| 486               | " -            | "        |                                  | No. 1 Battery                              | -                              |             |         | No. 1 Battery.              |
| 487               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Cossack."           |
| 488               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | " "Emerald."                |
| 489               | " -            | "        | 135                              | Do. -                                      | -                              |             |         | " "Duncan."                 |
| 490               | " -            | "        |                                  | Do. -                                      | -                              |             |         | " "Curaçoa."                |
| 491               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                  |
| 492               | " -            | "        |                                  | No. 8 Battery                              | -                              |             |         | No. 8 Battery.              |
| 493               | " -            | "        |                                  | Chatham -                                  | -                              |             |         | H.M.S. "Pylades."           |
| 494               | " -            | "        |                                  | Portsmouth -                               | -                              |             |         | " "Emerald."                |
| 495               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                  |
| 496               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Do.                         |
| 497               | " -            | "        |                                  | Cape                                       | -                              |             |         | Cape.                       |
| 498               | " -            | "        |                                  | Devonport -                                | -                              |             |         | Devonport.                  |
| 499               | " -            | "        |                                  | Do. -                                      | -                              |             |         | H.M.S. "Princess<br>Royal." |
| 500               | " -            | "        | 135                              | No. 5 Battery                              | -                              |             |         | No. 5 Battery.              |
| 501               | " -            | "        |                                  | Devonport -                                | -                              |             |         | H.M.S. "Princess<br>Royal." |
| 502               | " -            | "        |                                  | Do. -                                      | -                              |             |         | Devonport.                  |
| 503               | " -            | "        |                                  | Shoeburyness                               | -                              |             |         | } Store.                    |
| 504               | " -            | "        |                                  | Proving V. pieces                          | -                              |             |         | } +                         |
|                   |                |          |                                  | Devonport -                                | -                              |             |         | Devonport.                  |



Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.         |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|--------------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair. |                          |
|                   |                |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                          |
| 505               | 40-pounder -   | E. O. C. |                                  | No. 15 Battery -                           |                                |             |         | No. 15 Battery.          |
| 506               | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.               |
| 507               | " -            | "        |                                  | Cape -                                     |                                |             |         | Cape.                    |
| 508               | " -            | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Princess Royal." |
| 509               | " -            | "        |                                  | Do. -                                      |                                |             |         | " "Liverpool."           |
| 510               | " -            | "        |                                  | Do. -                                      |                                |             |         | Devonport.               |
| 511               | " -            | "        |                                  | Royal Mar., Plymouth                       |                                |             |         | Royal Mar., Plymouth.    |
| 512               | " -            | "        |                                  | No. 4 Battery -                            |                                |             |         | No. 4 Battery.           |
| 513               | " -            | "        |                                  | " 6 " -                                    |                                |             |         | " 6 "                    |
| 514               | " -            | "        |                                  | " 6 " -                                    |                                |             |         | " 6 "                    |
| 515               | " -            | "        |                                  | " 12 " -                                   |                                |             |         | " 12 "                   |
| 516               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Esk."            |
| 517               | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.               |
| 518               | " -            | "        |                                  | No. 7 Battery -                            |                                |             |         | No. 7 Battery.           |
| 519               | " -            | "        |                                  | " 13 " -                                   |                                |             |         | " 13 "                   |
| 520               | " -            | "        |                                  | Cape -                                     |                                |             |         | Cape.                    |
| 521               | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.               |
| 522               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                 |
| 523               | " -            | "        |                                  | No. 5 Battery -                            |                                |             |         | No. 5 Battery.           |
| 524               | " -            | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Liverpool."      |
| 525               | " -            | "        |                                  | Do. -                                      |                                |             |         | Devonport.               |
| 526               | " -            | "        |                                  | No. 8 Battery -                            |                                |             |         | No. 8 Battery.           |
| 527               | " -            | "        |                                  | Chatham -                                  |                                |             |         | H.M.S. "Pylades."        |
| 528               | " -            | "        |                                  | No. 5 Battery -                            |                                |             |         | No. 5 Battery.           |
| 529               | " -            | "        |                                  | " 7 " -                                    |                                |             |         | " 7 "                    |
| 530               | " -            | "        |                                  | " 4 " -                                    |                                |             |         | " 4 "                    |
| 531               | " -            | "        |                                  | " 9 " -                                    |                                |             |         | " 9 "                    |
| 532               | " -            | "        |                                  | H.M.S. "Excellent" -                       |                                |             |         | H.M.S. "Excellent."      |
| 533               | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.               |
| 534               | " -            | "        | 5                                | No. 6 Battery -                            |                                |             |         | No. 6 Battery.           |
| 535               | " -            | "        |                                  | Cape -                                     |                                |             |         | Cape.                    |
| 536               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                 |
| 537               | " -            | "        |                                  | No. 14 Battery -                           |                                |             |         | No. 14 Battery.          |
| 538               | " -            | "        |                                  | " 15 " -                                   |                                |             |         | " 15 "                   |
| 539               | " -            | "        |                                  | " 8 " -                                    |                                |             |         | " 8 "                    |
| 540               | " -            | "        |                                  | " 13 " -                                   |                                |             |         | " 13 "                   |
| 541               | " -            | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Princess Royal." |
| 542               | " -            | "        |                                  | Do. -                                      |                                |             |         | Devonport.               |
| 543               | " -            | "        |                                  | No. 12 Battery -                           |                                |             |         | No. 12 Battery.          |
| 544               | " -            | "        | 105                              | Shoeburyness -                             |                                |             |         | Shoeburyness.            |
| 545               | " -            | "        |                                  | No. 9 Battery -                            |                                |             |         | No. 9 Battery.           |
| 546               | " -            | "        |                                  | Royal Mar., Plymouth                       |                                |             |         | Royal Mar., Plymouth.    |
| 547               | " -            | "        |                                  | No. 10 Battery -                           |                                |             |         | No. 10 Battery.          |
| 548               | " -            | "        |                                  | " 13 " -                                   |                                |             |         | " 13 "                   |
| 549               | " -            | "        |                                  | " 13 " -                                   |                                |             |         | " 13 "                   |
| 550               | " -            | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Liverpool."      |
| 551               | " -            | "        |                                  | No. 14 Battery -                           |                                |             |         | No. 14 Battery.          |
| 552               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.G.B. "Fervent."      |
| 553               | " -            | "        |                                  | Do. -                                      |                                |             |         | " Earnest."              |
| 554               | " -            | "        |                                  | No. 15 Battery -                           |                                |             |         | No. 15 Battery.          |
| 555               | " -            | "        |                                  | " 9 " -                                    |                                |             |         | " 9 "                    |
| 556               | " -            | "        |                                  | " 10 " -                                   |                                |             |         | " 10 "                   |
| 558               | " -            | "        |                                  | " 7 " -                                    |                                |             |         | " 7 "                    |
| 559               | " -            | "        |                                  | " 14 " -                                   |                                |             |         | " 14 "                   |
| 560               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                 |
| 561               | " -            | "        |                                  | No. 11 Battery -                           |                                |             |         | No. 11 Battery.          |
| 562               | " -            | "        |                                  | " 9 " -                                    |                                |             |         | " 9 "                    |
| 563               | " -            | "        |                                  | " 12 " -                                   |                                |             |         | " 12 "                   |
| 564               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.              |
| 565               | " -            | "        |                                  | No. 11 Battery -                           |                                |             |         | No. 11 Battery.          |
| 566               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.G.B. "Charger."      |
| 567               | " -            | "        |                                  | No. 12 Battery -                           |                                |             |         | No. 12 Battery.          |
| 568               | " -            | "        |                                  | No. 11 " -                                 |                                |             |         | " 11 "                   |
| 569               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | H.M.S. "Esk."            |
| 570               | " -            | "        |                                  | Valparaiso -                               |                                |             |         | Valparaiso.              |
| 571               | " -            | "        |                                  | Devonport -                                |                                |             |         | H.M.S. "Liverpool."      |
| 572               | " -            | "        |                                  | No. 24 Battery -                           |                                |             |         | No. 24 Battery.          |
| 573               | " -            | "        |                                  | Portsmouth -                               |                                |             |         | Portsmouth.              |
| 574               | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.               |
| 575               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                 |
| 581               | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.               |
| 591               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                 |
| 593               | " -            | "        |                                  | Do. -                                      |                                |             |         | Do.                      |
| 596               | " -            | "        |                                  | Devonport -                                |                                |             |         | Devonport.               |
| 602               | " -            | "        |                                  | Chatham -                                  |                                |             |         | Chatham.                 |
| 603               | " -            | "        |                                  | Do. -                                      |                                |             |         | Do.                      |
| *21               | 70-pounder -   | E. O. C. |                                  | Shoeburyness -                             |                                |             |         | Shoeburyness.            |
| *27               | " -            | "        | 10 {                             | Do. -                                      |                                |             |         | } Do.                    |
| *34               | " -            | "        | 127 {                            | Do. -                                      |                                |             |         | } H.M.S. "Excellent."    |
|                   |                |          |                                  | H.M.S. "Excellent" -                       |                                |             |         |                          |

\* Experimental.

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.      |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|-----------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair. |                       |
|                   |                |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                       |
| 1                 | 110-pounder-   | E. O. C. |                                  | Dover - - -                                |                                |             |         | Dover.                |
| 2                 | " - - -        | "        |                                  | Shoeburyness - - -                         |                                |             | 49 16 0 | Portsmouth.           |
| 3                 | " - - -        | "        |                                  | Portsmouth - - -                           |                                |             |         | Malta.                |
| 4                 | " - - -        | "        |                                  | Malta - - -                                |                                |             |         | Do.                   |
| 5                 | " - - -        | "        | 17                               | Do. - - -                                  |                                |             |         | H.M.S. "Hannibal,"    |
| 6                 | " - - -        | "        | 12                               | Do. - - -                                  |                                |             |         | " "Cambridge."        |
| 7                 | " - - -        | "        |                                  | H.M.S. "Warrior" - - -                     |                                |             |         | " "Warrior."          |
| 8                 | " - - -        | "        |                                  | Fort Cumberland - - -                      |                                |             |         | Fort Cumberland.      |
| 9                 | " - - -        | "        |                                  | Malta - - -                                |                                |             |         | Malta.                |
| 10                | " - - -        | "        |                                  | Do. - - -                                  |                                |             |         | Do.                   |
| 11                | " - - -        | "        |                                  | Do. - - -                                  |                                |             |         | Do.                   |
| 12                | " - - -        | "        | 3                                | Do. - - -                                  |                                |             |         | Devonport.            |
| 13                | " - - -        | "        |                                  | Do. - - -                                  |                                |             |         | Malta.                |
| 14                | " - - -        | "        |                                  | Do. - - -                                  |                                |             |         | Devonport.            |
| 15                | " - - -        | "        |                                  | Do. - - -                                  |                                |             |         | Malta.                |
| 16                | " - - -        | "        | 67                               | Do. - - -                                  |                                |             |         | H.M.S. "Valourous."   |
| 17                | " - - -        | "        | 36                               | Do. - - -                                  |                                |             |         | " "Buzzard."          |
| 18                | " - - -        | "        |                                  | Do. - - -                                  |                                |             |         | Malta.                |
| 19                | " - - -        | "        |                                  | Do. - - -                                  |                                |             |         | Do.                   |
| 20                | " - - -        | "        |                                  | Chatham - - -                              |                                |             |         | H.M.S. "Galatea."     |
| 21                | " - - -        | "        | 55                               | Gibraltar - - -                            |                                |             |         | Gibraltar.            |
| 22                | " - - -        | "        | 10                               | Malta - - -                                |                                |             |         | Chatham.              |
| 23                | " - - -        | "        |                                  | Do. - - -                                  |                                |             |         | Malta.                |
| 24                | " - - -        | "        |                                  | Chatham - - -                              |                                |             |         | Chatham.              |
| 25                | " - - -        | "        |                                  | Gibraltar - - -                            |                                |             |         | Gibraltar.            |
| 27                | " - - -        | "        |                                  | Sandown Fort - - -                         |                                | 15 11 6     | - - -   | Sandown Fort.         |
|                   |                |          |                                  | O.S. Committee - - -                       |                                |             |         |                       |
| 28                | " - - -        | "        | 313                              | Do. - - -                                  |                                |             |         | Shoeburyness.         |
|                   |                |          |                                  | Proving V. pieces - - -                    |                                |             |         |                       |
| 29                | " - - -        | "        |                                  | Shoeburyness - - -                         |                                |             |         | Eastney Battery.      |
| 30                | " - - -        | "        |                                  | Eastney Battery - - -                      |                                |             |         | H.M.S. "Phoebe."      |
| 31                | " - - -        | "        |                                  | Devonport - - -                            |                                |             |         | Malta.                |
| 32                | " - - -        | "        |                                  | Malta - - -                                |                                |             |         | H.M.G.B. "Pheasant."  |
| 33                | " - - -        | "        |                                  | Portsmouth - - -                           |                                |             |         | Malta.                |
| 34                | " - - -        | "        |                                  | Malta - - -                                |                                |             |         | Do.                   |
| 35                | " - - -        | "        |                                  | Do. - - -                                  |                                |             |         | Fort Cumberland.      |
| 36                | " - - -        | "        |                                  | Fort Cumberland - - -                      |                                |             |         | Devonport.            |
| 37                | " - - -        | "        | 409                              | Devonport - - -                            |                                |             |         | Store.                |
| 38                | " - - -        | "        |                                  | Fort Cumberland - - -                      |                                |             |         | H.M.S. "Rattlesnake." |
| 39                | " - - -        | "        |                                  | Chatham - - -                              |                                |             |         | " "Euryalus."         |
| 40                | " - - -        | "        |                                  | Devonport - - -                            |                                |             |         | " "Warrior."          |
| 41                | " - - -        | "        |                                  | H.M.S. "Warrior" - - -                     |                                |             |         | Fort Victoria.        |
| 42                | " - - -        | "        |                                  | Fort Victoria - - -                        |                                |             |         | Portsmouth.           |
| 43                | " - - -        | "        |                                  | Portsmouth - - -                           |                                |             |         | Sandown Fort.         |
| 44                | " - - -        | "        |                                  | Sandown Fort - - -                         |                                |             |         | Devonport.            |
| 45                | " - - -        | "        |                                  | Devonport - - -                            |                                |             |         | Sheerness.            |
| 46                | " - - -        | "        |                                  | Sheerness - - -                            |                                |             |         | Sandown Fort.         |
| 47                | " - - -        | "        |                                  | Sandown Fort - - -                         |                                |             |         | Malta.                |
| 48                | " - - -        | "        | 4                                | Malta - - -                                |                                |             |         | Fort Cumberland.      |
| 49                | " - - -        | "        |                                  | Fort Cumberland - - -                      |                                |             |         | Malta.                |
| 50                | " - - -        | "        |                                  | Malta - - -                                |                                |             |         | Do.                   |
| 51                | " - - -        | "        | 11                               | Do. - - -                                  |                                |             |         | Do.                   |
| 52                | " - - -        | "        | 20                               | Do. - - -                                  |                                |             |         | Portsmouth.           |
| 53                | " - - -        | "        |                                  | Portsmouth - - -                           |                                |             |         | Sheerness.            |
| 54                | " - - -        | "        |                                  | Sheerness - - -                            |                                |             |         | Malta.                |
| 55                | " - - -        | "        |                                  | Malta - - -                                |                                |             |         | Corfu.                |
| 56                | " - - -        | "        | 42                               | Corfu - - -                                |                                |             |         | Fort Cumberland.      |
| 57                | " - - -        | "        |                                  | Fort Cumberland - - -                      |                                |             |         | Lumps Fort.           |
| 58                | " - - -        | "        |                                  | Lumps Fort - - -                           |                                |             |         | Blockhouse Fort.      |
| 59                | " - - -        | "        |                                  | Blockhouse Fort - - -                      |                                |             |         | Malta.                |
| 60                | " - - -        | "        |                                  | Malta - - -                                |                                |             |         | Bermuda.              |
| 61                | " - - -        | "        |                                  | Bermuda - - -                              |                                |             |         | Do.                   |
| 62                | " - - -        | "        |                                  | Do. - - -                                  |                                |             |         | Gibraltar.            |
| 63                | " - - -        | "        |                                  | Gibraltar - - -                            |                                |             |         | Plymouth.             |
| 64                | " - - -        | "        |                                  | Plymouth - - -                             |                                |             |         | Bermuda.              |
| 65                | " - - -        | "        |                                  | Bermuda - - -                              |                                |             |         | Gibraltar.            |
| 66                | " - - -        | "        |                                  | Gibraltar - - -                            |                                |             |         | Bermuda.              |
| 67                | " - - -        | "        |                                  | Bermuda - - -                              |                                |             |         | Sheerness.            |
| 68                | " - - -        | "        |                                  | Sheerness - - -                            |                                |             |         | Bermuda.              |
| 69                | " - - -        | "        |                                  | Bermuda - - -                              |                                |             |         | Do.                   |
| 70                | " - - -        | "        |                                  | Do. - - -                                  |                                |             |         | Malta.                |
| 71                | " - - -        | "        | 23                               | Malta - - -                                |                                |             |         | Bermuda.              |
| 72                | " - - -        | "        |                                  | Bermuda - - -                              |                                |             |         | Sandown Fort.         |
| 73                | " - - -        | "        |                                  | Sandown Fort - - -                         |                                |             |         | Bermuda.              |
| 74                | " - - -        | "        |                                  | Bermuda - - -                              |                                |             |         | Sheerness.            |
| 75                | " - - -        | "        |                                  | Sheerness - - -                            |                                |             |         | Gibraltar.            |
| 76                | " - - -        | "        |                                  | Gibraltar - - -                            |                                |             |         | Sheerness.            |
| 77                | " - - -        | "        |                                  | Sheerness - - -                            |                                |             |         | Freshwater Redoubt.   |
| 78                | " - - -        | "        |                                  | Freshwater Redoubt - - -                   |                                |             |         | Gibraltar.            |
| 79                | " - - -        | "        |                                  | Gibraltar - - -                            |                                |             |         | Malta.                |
| 80                | " - - -        | "        |                                  | Malta - - -                                |                                | 14 2 6      | 0 7 2   | Sandown Fort.         |
| 81                | " - - -        | "        |                                  | H.M.S. "Devastation" - - -                 |                                |             |         | H.M.S. "Severn."      |
| 82                | " - - -        | "        |                                  | Sandown Fort - - -                         |                                |             |         | Devonport.            |
| 83                | " - - -        | "        |                                  | Portsmouth - - -                           |                                |             |         | Portsmouth.           |
| 84                | " - - -        | "        |                                  | Devonport - - -                            |                                |             |         |                       |



Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun. | Maker.   | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.       |
|-------------------|----------------|----------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|------------------------|
|                   |                |          |                                  |                                            |                                | Alteration. | Repair. |                        |
|                   |                |          |                                  |                                            |                                | £ s. d.     | £ s. d. |                        |
| 85                | 110-pounder    | E. O. C. | 19                               | H.M.S. "Devastation"                       |                                |             |         | H.M.S. "Devastation."  |
| 86                | "              | "        |                                  | Portsmouth                                 |                                |             |         | " "Severn."            |
| 87                | "              | "        |                                  | Devonport                                  |                                |             |         | " "Warrior."           |
| 88                | "              | "        |                                  | H.M.S. "Devastation"                       |                                |             |         | " "Devastation."       |
| 89                | "              | "        |                                  | Halifax                                    |                                |             |         | Halifax.               |
| 90                | "              | "        |                                  | Portsmouth                                 |                                |             |         | H.M.S. "Warrior."      |
| 91                | "              | "        |                                  | Do.                                        |                                |             |         | " "Esk."               |
| 92                | "              | "        |                                  | Do.                                        |                                |             |         | Portsmouth.            |
| 93                | "              | "        |                                  | Devonport                                  |                                |             |         | H.M.S. "Canopus."      |
| 94                | "              | "        |                                  | Portsmouth                                 |                                |             |         | " "Warrior."           |
| 95                | "              | "        |                                  | Do.                                        |                                |             |         | " "                    |
| 96                | "              | "        |                                  | Halifax                                    |                                |             |         | Halifax.               |
| 97                | "              | "        |                                  | Chatham                                    |                                |             |         | Chatham.               |
| 98                | "              | "        |                                  | Halifax                                    |                                |             |         | Halifax.               |
| 99                | "              | "        |                                  | Do.                                        |                                |             |         | Do.                    |
| 100               | "              | "        |                                  | Do.                                        |                                |             |         | Do.                    |
| 101               | "              | "        |                                  | Do.                                        |                                |             |         | Do.                    |
| 102               | "              | "        |                                  | Devonport                                  |                                |             |         | H.M.S. "Warrior."      |
| 103               | "              | "        |                                  | Do.                                        |                                |             |         | Devonport.             |
| 104               | "              | "        |                                  | Portsmouth                                 |                                |             |         | Portsmouth.            |
| 105               | "              | "        |                                  | Bermuda                                    |                                |             |         | Bermuda.               |
| 106               | "              | "        |                                  | Halifax                                    |                                |             |         | Halifax.               |
| 107               | "              | "        |                                  | Chatham                                    |                                |             |         | Chatham.               |
| 108               | "              | "        |                                  | Do.                                        |                                |             |         | H.M.S. "Defence."      |
| 109               | "              | "        |                                  | Do.                                        |                                |             |         | Chatham.               |
| 110               | "              | "        |                                  | Do.                                        |                                |             |         | Do.                    |
| 111               | "              | "        |                                  | Halifax                                    |                                |             |         | Halifax.               |
| 112               | "              | "        |                                  | Do.                                        |                                |             |         | Do.                    |
| 113               | "              | "        |                                  | Portsmouth                                 |                                |             |         | H.M.S. "Warrior."      |
| 114               | "              | "        |                                  | Do.                                        |                                |             |         | Portsmouth.            |
| 115               | "              | "        | 7                                | Do.                                        |                                |             |         | Do.                    |
| 116               | "              | "        |                                  | Do.                                        |                                |             |         | H.M.S. "Warrior."      |
| 117               | "              | "        |                                  | Do.                                        |                                |             |         | Portsmouth.            |
| 119               | "              | "        |                                  | Do.                                        |                                |             |         | H.M.S. "Warrior."      |
| 120               | "              | "        |                                  | Chatham                                    |                                |             |         | H.M.G.B. "Ruby."       |
| 121               | "              | "        |                                  | Halifax                                    |                                |             |         | Halifax.               |
| 122               | "              | "        |                                  | Chatham                                    |                                |             |         | H.M.S. "Meanee."       |
| 123               | "              | "        |                                  | Do.                                        |                                |             |         | " "Defence."           |
| 124               | "              | "        |                                  | Do.                                        |                                |             |         | H.M.G.B. "Spanker."    |
| 125               | "              | "        |                                  | Portsmouth                                 |                                |             |         | Portsmouth.            |
| 126               | "              | "        |                                  | Cliffend Fort                              |                                |             |         | Cliffend Fort.         |
| 127               | "              | "        |                                  | Sandown Fort                               |                                |             |         | Sandown Fort.          |
| 128               | "              | "        |                                  | Devonport                                  |                                |             |         | Devonport.             |
| 129               | "              | "        |                                  | Dover                                      |                                |             |         | Dover.                 |
| 130               | "              | "        |                                  | H.M.S. "Archer"                            |                                |             |         | H.M.S. "Archer."       |
| 131               | "              | "        |                                  | Devonport                                  |                                |             |         | " "Severn."            |
| 132               | "              | "        |                                  | Dover                                      |                                |             |         | Dover.                 |
| 133               | "              | "        |                                  | Fort Victoria                              |                                |             |         | Fort Victoria.         |
| 134               | "              | "        |                                  | Eastney Battery                            |                                |             |         | Eastney Battery.       |
| 135               | "              | "        |                                  | Portsmouth                                 |                                |             |         | Portsmouth.            |
| 136               | "              | "        |                                  | Dungeness                                  |                                |             |         | Dungeness.             |
| 138               | "              | "        | 53                               | Shoeburyness                               |                                |             |         | Shoeburyness.          |
| 139               | "              | "        |                                  | Chatham                                    |                                |             |         | Chatham.               |
| 140               | "              | "        |                                  | Portsmouth                                 |                                |             |         | H.M.S. "Blk. Prince."  |
| 141               | "              | "        |                                  | Chatham                                    |                                |             |         | H.M.G.B. "Bullfrog."   |
| 142               | "              | "        |                                  | Do.                                        |                                |             |         | H.M.S. "Defence."      |
| 143               | "              | "        |                                  |                                            |                                |             |         | Store.                 |
| 144               | "              | "        |                                  | Chatham                                    |                                |             | 30 10 9 | H.M.S. "Defence."      |
| 145               | "              | "        |                                  | Portsmouth                                 |                                |             |         | Portsmouth.            |
| 146               | "              | "        |                                  | Sandown Battery                            |                                |             |         | Sandown Battery.       |
| 147               | "              | "        | 42                               | Dover                                      |                                |             |         | Dover.                 |
| 148               | "              | "        |                                  | Portsmouth                                 |                                |             |         | Portsmouth.            |
| 149               | "              | "        |                                  | Cliffend Fort                              |                                |             |         | Cliffend Fort.         |
| 150               | "              | "        |                                  | Portsmouth                                 |                                |             |         | Portsmouth.            |
| 151               | "              | "        |                                  | Eastney Battery                            |                                |             |         | Eastney Battery.       |
| 152               | "              | "        |                                  | Dover                                      |                                |             |         | Dover.                 |
| 153               | "              | "        |                                  | Sandown Fort                               |                                |             |         | Sandown Fort.          |
| 154               | "              | "        |                                  | Fort Cumberland                            |                                |             |         | Fort Cumberland.       |
| 155               | "              | "        |                                  | Sandown Fort                               |                                |             |         | Sandown Fort.          |
| 156               | "              | "        |                                  | Portsmouth                                 |                                |             |         | Portsmouth.            |
| 157               | "              | "        |                                  | Do.                                        |                                |             |         | Do.                    |
| 158               | "              | "        |                                  | Do.                                        |                                |             |         | Do.                    |
| 159               | "              | "        |                                  | Do.                                        |                                |             |         | Do.                    |
| 160               | "              | "        |                                  | Do.                                        |                                |             |         | Do.                    |
| 161               | "              | "        |                                  | Do.                                        |                                |             |         | Do.                    |
| 162               | "              | "        |                                  | Devonport                                  |                                |             |         | H.M.S. "Canopus."      |
| 163               | "              | "        |                                  | Chatham                                    |                                |             |         | Chatham.               |
| 164               | "              | "        |                                  | Portsmouth                                 |                                |             |         | Portsmouth.            |
| 165               | "              | "        |                                  | Cliffend Fort                              |                                |             |         | Cliffend Fort.         |
| 166               | "              | "        |                                  | Sandown Fort                               |                                |             |         | Sandown Fort.          |
| 167               | "              | "        |                                  | Chatham                                    |                                |             |         | H.M.G.B. "Heron."      |
| 168               | "              | "        |                                  | Portsmouth                                 |                                |             |         | H.M.S. "Black Prince." |
| 169               | "              | "        |                                  | Do.                                        |                                |             |         | Portsmouth.            |
| 170               | "              | "        |                                  | Chatham                                    |                                |             |         | H.M.S. "Defence."      |
| 171               | "              | "        |                                  | Bermuda                                    |                                |             |         | Bermuda.               |
| 172               | "              | "        |                                  | Devonport                                  |                                |             |         | Devonport.             |
| 173               | "              | "        |                                  | Chatham                                    |                                |             |         | Chatham.               |

Return of Armstrong Guns issued—*continued.*

| No.<br>of<br>Gun. | Nature of Gun. | Maker. | Number<br>of<br>Rounds<br>fired. | Station or Service<br>for<br>which issued. | Present<br>State<br>of<br>Gun. | Cost of     |         | Present Station.    |
|-------------------|----------------|--------|----------------------------------|--------------------------------------------|--------------------------------|-------------|---------|---------------------|
|                   |                |        |                                  |                                            |                                | Alteration. | Repair. |                     |
|                   |                |        |                                  |                                            |                                | £ s. d.     | £ s. d. |                     |
| 174               | 110-pounder -  | -      | E. O. C.                         | Chatham -                                  | -                              |             |         | H.M.S. "Meanee."    |
| 176               | " -            | -      | "                                | Portsmouth -                               | -                              |             |         | Portsmouth.         |
| 177               | " -            | -      | "                                | Chatham -                                  | -                              |             |         | Chatham.            |
| 178               | " -            | -      | "                                | Portsmouth -                               | -                              |             |         | Portsmouth.         |
| 179               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |
| 180               | " -            | -      | "                                | Eastney Battery -                          | -                              |             |         | Eastney Battery.    |
| 181               | " -            | -      | "                                | Chatham -                                  | -                              |             |         | H.M.S. "Eclipse."   |
| 182               | " -            | -      | "                                | Portsmouth -                               | -                              |             |         | Portsmouth.         |
| 183               | " -            | -      | "                                | Bermuda -                                  | -                              |             |         | Bermuda.            |
| 184               | " -            | -      | "                                | Devonport -                                | -                              |             |         | Devonport.          |
| 185               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |
| 186               | " -            | -      | "                                | Chatham -                                  | -                              |             |         | Chatham.            |
| 187               | " -            | -      | "                                | Malta -                                    | -                              |             |         | Malta.              |
| 188               | " -            | -      | "                                | Devonport -                                | -                              |             |         | H.M.S. "Canopus."   |
| 189               | " -            | -      | "                                | Chatham -                                  | -                              |             |         | " "Defence."        |
| 190               | " -            | -      | "                                | H.M.S. "Osprey" -                          | -                              |             |         | " "Osprey."         |
| 191               | " -            | -      | "                                | -                                          | +                              | - - -       | 34 5 6  | Store.              |
| 192               | " -            | -      | "                                | Devonport -                                | -                              |             |         | Devonport.          |
| 193               | " -            | -      | "                                | Sandown Fort -                             | -                              |             |         | Sandown Fort.       |
| 194               | " -            | -      | "                                | Sandown Battery -                          | -                              |             |         | Sandown Battery.    |
| 195               | " -            | -      | "                                | Dover -                                    | -                              |             |         | Dover.              |
| 196               | " -            | -      | "                                | Cliffend Fort -                            | -                              |             |         | Cliffend Fort.      |
| 197               | " -            | -      | "                                | Portsmouth -                               | -                              |             |         | Portsmouth.         |
| 198               | " -            | -      | "                                | Sandown Fort -                             | -                              |             |         | Sandown Fort.       |
| 199               | " -            | -      | "                                | Sandown Battery -                          | -                              |             |         | Sandown Battery.    |
| 200               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |
| 201               | " -            | -      | "                                | Eastney Battery -                          | -                              |             |         | Eastney Battery.    |
| 203               | " -            | -      | "                                | Sandown Battery -                          | -                              |             |         | Sandown Battery.    |
| 204               | " -            | -      | "                                | Sandown Fort -                             | -                              |             |         | Sandown Fort.       |
| 205               | " -            | -      | "                                | Portsmouth -                               | -                              |             |         | H.M.G.B. "Tervent." |
| 206               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Portsmouth.         |
| 207               | " -            | -      | "                                | Sandown Fort -                             | -                              |             |         | Sandown Fort.       |
| 208               | " -            | -      | "                                | Eastney Battery -                          | -                              |             |         | Eastney Battery.    |
| 209               | " -            | -      | "                                | Chatham -                                  | -                              |             |         | Chatham.            |
| 210               | " -            | -      | "                                | Portsmouth -                               | -                              |             |         | Portsmouth.         |
| 211               | " -            | -      | "                                | Chatham -                                  | -                              |             |         | Chatham.            |
| 212               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |
| 213               | " -            | -      | "                                | Portsmouth -                               | -                              |             |         | Portsmouth.         |
| 214               | " -            | -      | "                                | Chatham -                                  | -                              |             |         | Chatham.            |
| 215               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |
| 216               | " -            | -      | "                                | Portsmouth -                               | -                              |             |         | Portsmouth.         |
| 217               | " -            | -      | "                                | Chatham -                                  | -                              |             |         | Chatham.            |
| 218               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |
| 219               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |
| 220               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |
| 222               | " -            | -      | "                                | Portsmouth -                               | -                              |             |         | Portsmouth.         |
| 223               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |
| 226               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |
| 230               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |
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| 244               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |
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| 246               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |
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| 257               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |
| 258               | " -            | -      | "                                | Do. -                                      | -                              |             |         | Do.                 |



SIR, Manchester, January 29, 1863.

IN reply to your letter of the 26th instant, I beg to state that it will afford me much pleasure to show the whole of the manufacture of my ordnance to the Committee, and make them thoroughly acquainted with it. This, however, I should prefer doing after the comparative trials between Sir William Armstrong's guns and mine have been made.

I think the most important part of the proposed trials may soon be made, if my firm can receive the order for the guns which will be required.

I shall be most happy at any time to see the Committee at our office in Pall Mall, where I can further explain the principle of the guns and projectiles by means of the models which are there.

In answer to your second letter of the 26th, I have to inform you that the drawings of the 12-pr. and 70-pr. guns and ammunition necessary in order to make the carriages for them are in hand, and shall be sent up in a few days, also the proof sheet of my evidence.

I am, &c.

Capt. H. Dyer, R.A.,  
Secretary.

JOSEPH WHITWORTH.

SIR, Manchester, February 17, 1863.

I AM desired by Mr. Whitworth, in his absence, to acknowledge the receipt of your letter No. 18, ordering three 12-pr. and three 70-pr. (5½") homogeneous metal rifled guns, to be submitted to the "Special Armstrong and Whitworth Committee" for experimental purposes, and for which an official order will come from Woolwich in the usual way.

The guns will be completed as early as possible, and will probably be as follows:—Three 12-pr. guns in three, four, and six weeks; three 70-pr. guns in three, six, and eight weeks.

It would be desirable for the shot and shell to be ordered, so that they may be being proceeded with at the same time as the guns.

I am, &c.

Capt. H. Dyer, R.A.,  
Secretary.

WILLIAM W. HULSE.

28, Pall Mall, London, S.W.,

June 17, 1863.

SIR,

IN reply to your letter No. 212, we beg to say that the cartridges with Boxer's lubricator attached, which you have sent from the Royal Laboratory, appear to be suitable, but we should be glad to be favoured with 100 for the 12-pr. guns, to give them a trial.

With reference to the delivery of Whitworth guns, we are really in the hands of the manufacturers of the homogeneous metal used for the guns. They have been for some time endeavouring to get to work hammers of the weight which we find absolutely necessary for properly manufacturing the metal in the heavy masses required for the large guns, and we are unwilling to risk the guns made with the lighter hammers now in operation in this country.

It is a great disappointment to us that the manufacturers have not yet been able to put into operation the more powerful hammers they have undertaken to employ, but which they now confidently state will be at work in six weeks' time.

Under these circumstances we regret to inform the Committee that we must still ask for further time for the delivery of the guns.

We fear this delay may lead to observations unfavourable to us, but we prefer to submit to them rather than we should send in a gun for trial that we do not feel would be the best gun that can be produced by us.

We are, &c.

MANCHESTER ORDNANCE & RIFLE CO.

Capt. H. Dyer, R.A.,  
Secretary.

Sackville Street, Manchester,

September 4, 1863.

DEAR SIR,

I AM happy to inform you that we are now in a position to state that the rifled guns to be submitted to the "Special Armstrong and Whitworth Committee" will be ready for delivery in three to four weeks.

I am, &c.

Capt. H. Dyer, R.A.,  
Secretary.

WILLIAM W. HULSE.

Sackville Street, Manchester,

October 2, 1863.

SIR,

WILL you oblige us by kindly sending to Colonel Boxer a copy of the programme sent to us, as we presume he will have to provide the cartridges, fuses, &c., to be used with our shells in the forthcoming trials.

We propose sending on Wednesday next, the 7th instant, to Woolwich, a 12-pr. gun, with pattern shot and shell, to be tried in the carriages and limbers made in the Royal Carriage Department.

We learn from Mr. Hulse, who has just returned from Woolwich, that the 70-pr. guns will not be required until the trials with the 12-pr. guns are completed; they will, however, soon be ready.

We are, &c.

MANCHESTER ORDNANCE & RIFLE CO.

Capt. H. Dyer, R.A.,  
Secretary.

Sackville Street, Manchester,

December 17, 1863.

SIR,

IN reply to your letter of yesterday, No. 154, Mr. Whitworth desires me to say, that a misunderstanding has arisen about the delivery of the 70-pr. gun, and that he did not intend to imply it had been despatched. I am, however, happy to be able to state that it will be ready, with its ammunition, for the experiments to take place in the ensuing month.

I am, &c.

Capt. H. Dyer, R.A.,  
Secretary.

WILLIAM W. HULSE.

Sackville Street Manchester,

January 12, 1864.

SIR,

WE have to acknowledge receipt of letter No. 7350/9609, dated 9th instant.

We will forward to the Principal Superintendent of Stores at Woolwich bills for the stores which we have supplied for the Armstrong and Whitworth Committee.

In answer to your question as to when the heavy guns we are manufacturing will be ready, we beg to say we expect to begin to deliver them in the course of the ensuing week.

We are, &c.

MANCHESTER ORDNANCE & RIFLE CO.

The Under Secretary of State for War,  
War Office, London.

Sackville Street, Manchester,

January 26, 1864.

SIR,

MR. WHITWORTH requests me to acknowledge your letter No. 182, and to state that in the course of next week he will fix a definite period when the whole of his guns and ammunition, both 12 and 70-prs. will be delivered at Woolwich.

I am, &c.

Capt. H. Dyer, R.A.,  
Secretary.

WILLIAM W. HULSE.

Sackville Street, Manchester,

January 28, 1864.

SIR,

I HAVE to acknowledge the receipt, this afternoon, of letter dated War Office, January 26, 1864, and beg to make the request that 10 rounds of case shot per gun for my 12-pr. muzzle-loader guns may be supplied from the Royal Laboratory for the trials of the Armstrong and Whitworth Committee.

I observe in the copy of letter No. 7663/103, addressed to the Manchester Ordnance Company, enclosed in the above letter, it is stated that "the experiments will take place on the 2nd or 3rd February next." A letter, No. 182, received from the Committee on the 26th instant, states that the Committee have decided not to commence before the whole of the guns and ammunition have been received at Woolwich.

It was previously understood that the trial with the 12-pr. would be completed before those with the 70-pr. commenced, and it is now not possible that the 70-pr. guns and ammunition can be delivered so early.

I am, &c.

The Under Secretary of State,  
War Office.

J. WHITWORTH.

Sackville Street, Manchester,  
February 5, 1864.  
SIR, In accordance with the promise made to the Committee on their visit to our works yesterday, I beg to inform you that the whole of the guns, both 12-pr. and 70-pr., together with the solid shot and common shell, and proof shot, will be delivered here on the 14th March next.  
I am, &c.  
Capt. H. Dyer, R.A.,  
Secretary. JOSEPH WHITWORTH.

I mention the foregoing particulars in order to save confusion, and have communicated with the secretary further upon the subject.

I have, &c.  
The President of the Special  
Committee on Armstrong and  
Whitworth Guns,  
&c. &c. &c.  
109, Victoria Street, S.W.  
H. W. GORDON.

Sackville Street, Manchester,  
March 14, 1864.  
SIR, We beg to advise you of having this day commenced the despatch of the guns and ammunition, with the exception of the shrapnel shells and case shot, for the Armstrong and Whitworth Committee, and will complete the whole by Wednesday. We are sending the common shells to the Royal Laboratory, and the guns and solid shot to the storekeeper, Woolwich.  
We are including six double shot for the proof of the 70-pr. guns, although not ordered. We are also sending five cast-iron flat-front shot to act as pioneers to the more expensive steel flat-fronted shot and shell ordered.  
We are, &c.  
Capt. H. Dyer, R.A.,  
Secretary. Manchester Ordnance and  
Rifle Company.  
NICHOLAS HEALD,  
Secretary.

SIR, Newcastle-on-Tyne, February 26, 1863.

REFERRING to your letter of the 24th instant, I beg to state that the two 12-pr. breech-loading Armstrong guns, which have been ordered in the Royal Gun Factory, were so ordered with my approval for use by the Committee.

One of these guns is an old one which has already resisted an extremely severe course of tests, and which I intended to offer to the Committee for any further trial of endurance they might decide upon making.

The other is a new gun of the present service pattern. When these guns were ordered I was not aware that the Committee would carry on their practice with more than one gun, but as I now learn that three guns will be required for this purpose, I should wish to be authorized to furnish from Elswick two new guns, which, with one of those from Woolwich (viz., the new one), will make up the three required by the Committee.

I should still, however, wish to submit to the Committee the other gun ordered from Woolwich, partly as a spare gun and partly for the purpose of having its endurance further tested if the Committee should so desire.

With regard to the 70-pr., I perceive from the list of ammunition demanded by the Committee, that it is their intention to try these guns against iron plates. Upon this point I feel it necessary to observe that my 70-pr. guns, which weigh 60 cwt., were designed by me as substitutes for the present 32-prs. of 58 cwt., and were never expected to be effective against iron defences. Had they been intended for that service I should certainly have felt it requisite to make the weight considerably greater, but in that case the intention of providing a substitute for the 32-pr. would have been defeated. Mr. Whitworth's 70-pr. is a gun of 80 cwt., and I feel it indispensable that I should supply a 70-pr. of the same weight if it has to be put in comparison with his in experiments against armour plates.

As I understand, however, that Mr. Whitworth will only use a muzzle-loading 70-pr., I should conceive it will not be necessary for me to supply breech-loaders of this extra weight. Perhaps also the Committee would be satisfied to have one of my three muzzle-loading 70-prs. of such a weight as I should deem requisite for operating against plates, leaving the other two to pass as guns of a lighter pattern to fulfil the original intention of furnishing a more powerful gun as a substitute for the present 32-pr. smooth bore.

I have, &c.  
The Secretary, Special  
Whitworth and Armstrong  
Committee. W. G. ARMSTRONG.

January 23, 1865.  
SIR, I HAVE the honour to inform the Armstrong and Whitworth Committee that the trunnion of a 12-pr. Whitworth gun, forwarded to me by Major Young, has been submitted to examination with the view of ascertaining the nature of the metal composing it.

The metal contained a trace of graphitic carbon and a small proportion of combined carbon, slightly above what is found in malleable (wrought) iron of good quality. A polished surface of the metal, when submitted to dissection, furnished evidence of structure which left no doubt that the trunnion did not consist of cast metal, and that it was not originally homogeneous in its character.

The proportion of sulphur in the metal was only minute, but silicon and phosphorus were found in more considerable quantities; of the former 0.18 per cent. was discovered, and the proportion of phosphorus corresponded to 0.15 per cent.

The conclusion to be drawn from the examination of the trunnion is, that it was manufactured of malleable (forged) iron of indifferent quality.

The photographs of the trunnion and the guns will be furnished to the Committee through the Principal Superintendent of Stores, Woolwich, as soon as complete.

I have, &c.  
The Secretary, Armstrong  
and Whitworth Committee. F. A. ABEL,  
Chemist of the War  
Department.

Military Store Office, Woolwich, S.E.,  
February 6, 1863.

SIR, In accordance with the orders of the Secretary of State for War, dated 5/2/63, 7663/30, upon which you are authorized to demand upon me for such stores as you may from time to time require, after the special approval of the War Committee has been obtained;

I have the honour to state that the following orders have already been given for guns, connected with your Committee.

On order 17/1/63, 7663/14, from Royal Gun Factories for Sir W. Armstrong, C.B.:—

Two 110-pr. guns with steel tempered vent pieces.

Two 12-pr. breech-loading guns, with tempered steel breech screws and vent pieces.

From the Elswick Ordnance Company, on order 17/1/63, 7663/6:—

Two 40-pr. with tempered steel linings.

One 12-pr. muzzle loading.

There are also due from the Whitworth Company, on order, 10/1/63, 80/W.743, and /709, three 12-pr. guns of homogeneous metal.

And from the Royal Gun Factories, three 12-pr. brass guns.

SIR, Newcastle-on-Tyne, October 27, 1863.

As all recent experience, both in this country and abroad, has proved that iron plated ships can only be successfully attacked with guns of the largest calibre, and as the 70-pr. guns which have been ordered of Mr. Whitworth and myself can only be regarded as guns fit to be used against timber ships and fortresses of ordinary construction, I beg leave to suggest the expediency of the Committee obtaining authority to order for trial a couple of Whitworth and Armstrong guns of sufficient size to be used with proper effect against targets representing the sides of iron plated ships.

The guns which I recommend for this purpose are,—

1st. A rifled gun of 6½ tons weight, with a calibre equal to that of the 68-pr., so as to be capable of utilizing, if desired, the spherical projectiles of that gun. This gun I propose as a broadside gun, and I believe it will be the lightest that will be found decisively effective against armour plates.

2nd. A rifled gun of 12 tons, having a bore of 10 inches, to suit the spherical projectiles of the present 10-inch



smooth-bore guns. This I propose as a gun adapted for cupola ships and batteries.

I have, &c.

The Secretary, Special  
Armstrong and Whitworth  
Committee.

W. G. ARMSTRONG.

8, Great George Street, Westminster,  
January 25, 1864.

SIR,

THE Committee are aware that the guns and ammunition demanded of me by the Committee for the competitive trials with Mr. Whitworth's guns, were reported ready for delivery in April 1863; and that the guns and ammunition have since been delivered to the Committee in accordance with their desire.

I am informed that it is the intention of the Committee to commence their experiments forthwith. I beg therefore to inquire whether Mr. Whitworth has delivered the 12-pr. and 70-pr. guns and ammunition required by the Committee for the purposes of their trials. It appears to me necessary that each competitor should deliver to the Committee all that is requisite for fully carrying out the Committee's programme of trial *before the commencement of the trials*, as a security against change and delay during the trials, and as a pledge for their not being discontinued after partial results have been obtained. The obligation to deliver all the guns and ammunition having been enforced upon me, it is obvious that it should also be enforced upon Mr. Whitworth.

I may remind the Committee that they have declined my request to permit the trials to be extended to guns of larger dimensions than the 70-pr., and I therefore feel the more entitled to ask for a guarantee, before the experiments begin, that at all events the 70-pr. shall be tried.

I have, &c.

The Secretary, Armstrong  
and Whitworth Committee.

W. G. ARMSTRONG.

8, Great George Street, Westminster,  
January 25, 1864.

SIR,

I AM informed that the Committee have recently determined to test the fuzes to be used in the forthcoming trials in a manner lately devised by Col. Boxer, viz. by jolting them in a special machine.

I beg to observe that the fuzes already delivered by me have been designed without reference to such a test. They have been prepared to endure the Government test of two falls upon iron from a height of 30 feet, and are in this respect like the service fuzes, which, by the express wish of the authorities, are made as sensitive as possible within the limits of the above test, in order that they may explode with certainty when fired with very low charges. If the Committee have decided upon employing the new test of Col. Boxer, introduced since my fuzes were delivered, I shall be glad of an opportunity of supplying them with fuzes more adapted to endure it than those now in the hands of the Committee. I do not propose to withdraw the present fuzes, but only to substitute altered ones in the event of the Committee not having had occasion to use any fuzes before the substitution can take place. If the Committee determine to proceed with the present fuzes the tests which were in existence when the fuzes were delivered should alone be applied. In order to fit the fuzes for the new test no other alteration will be needed than a slight modification of the igniting pellet.

I have, &c.

The Secretary, Armstrong  
and Whitworth Committee.

W. G. ARMSTRONG.

Immediate.

War Office, February 27, 1864.

SIR,

I AM directed by Earl de Grey and Ripon to inform you that with the concurrence of the Lords Commissioners of the Admiralty he has decided the competitive trial of the Armstrong and Whitworth guns must commence not later than the 1st of April next, and that it is to be carried on from day to day until it is finished.

If the competing guns, with all their ammunition, are not on the ground by the 1st of April, the inventor whose gun, or ammunition, or any part of it, has not been delivered, will be regarded by Earl de Grey and Ripon as having declined to enter the competition.

I am, &c.

The President of the  
Armstrong and Whitworth Committee.

J. ST. GEORGE, Major-Gen.,  
Director of Ordnance.

Royal Hotel, Southend,  
April 6, 1864.

SIR,

I UNDERSTAND that Col. Boxer, Superintendent of the Royal Laboratory, has made application to the Committee to be allowed to withdraw for experiment some of the ammunition supplied by him for Mr. Whitworth's guns.

The Committee are aware that Col. Boxer is in reality my competitor with respect to the ammunition in question, and there is therefore quite as much objection to Col. Boxer's withdrawing part of his ammunition as there would be to Mr. Whitworth's withdrawing one of his guns.

Considering that all the experiments connected with the ammunition for my shunt 12-pr. gun have been made at the expense of the firm to which I belong, while for the new ammunition specially prepared for the experiments with Mr. Whitworth's guns all the resources of the Royal Laboratory have been made available at the Government expense, I feel justified in objecting to any interference with any part of the material supplied for the present competitive trials.

I have, &c.

To the Secretary, Armstrong  
and Whitworth Committee.

W. G. ARMSTRONG.

Royal Laboratory, Woolwich, S.E.,  
April 29, 1864.

SIR,

As I am responsible for the fuzes and shrapnel shells which have been furnished for the Whitworth guns, I venture to offer the following remarks for your consideration.

I presume that the object of the experiments which are now being carried out by the Armstrong and Whitworth Committee, is to obtain the necessary data to determine the relative efficiency of *each separate portion* of the equipment submitted by Sir W. Armstrong and Mr. Whitworth.

With respect to that portion for which I am answerable, no satisfactory conclusions can, in my opinion, be arrived at unless the following arrangements are adopted:—

1st. The trial of fuzes should, as far as possible, be kept distinct from the trial of shells, and when combined, the results should be recorded in such a way that the errors due to the one may be eliminated from those due to the other.

2ndly. Each description of fuze should be tried separately, and when the object is to determine the relative efficiency of different description of fuzes for specific purposes, the conditions should be varied to correspond in some degree with the circumstances likely to attend their employment in actual warfare.

3rdly. In the trial of common shells, the same number of hits and bursts should be obtained in each case, independently of the number of rounds fired; and when the effect depends materially upon the projectile striking a particular part of the obstacle, the hits should be made to correspond in this respect.

4thly. In the trial of shrapnel and segment shells the position of the targets should be varied to represent the different formations of troops, boats, &c., also the effect of varying, within reasonable limits, the distance of the burst from the targets, and the elevation of the gun at each range should be carefully ascertained; moreover, in order to ascertain the relative efficiency of shrapnel and segment shells fitted with time and concussion fuzes, the targets should be placed upon ground such as that ordinarily met with in the field.

The importance of adopting this course must be evident when the following circumstances are duly considered:—

1stly. In actual warfare the distance of the object will seldom be known with sufficient accuracy to ensure perfection, either in the elevation of the gun or in the adjustment of the fuze.

2ndly. When the range is known, the same accuracy in elevating the gun and in adjusting the fuze which is attained at target practice, cannot reasonably be expected in the field; and—

3rdly. On service the ground will seldom be of the favourable character for the action of shrapnels fitted with concussion fuzes, which is obtained on certain portions of the range at Shoeburyness.

I beg to point out that in designing the shrapnel for the Whitworth gun, my object was not to produce a great show upon a target under exceptional conditions; but to obtain an average good result under such circumstances as are likely to arise in warfare, and I am naturally anxious that this quality should be properly and fairly tested.

In the trials which were made against earthworks, the effects produced by the shrapnel from the Whitworth gun and the segment shell from the Armstrong gun are, *apart from other circumstances attending the practice*, exceedingly likely to mislead.

In firing at the abbatiss in front of the work, the only real damage was done by two of the segment shell from the muzzle-loading Armstrong, and two from the Armstrong breech-loader; but from a careful inspection of the work it appeared that the superior effect produced by the segment shell from the Armstrong guns was not due to any peculiarity in the arrangement of this particular projectile, but was caused by the segment shells having struck in the only spot where real damage could be effected, whilst the shrapnel from the Whitworth had failed, from some accidental cause, to strike in a favourable spot.

The same remark applies to the experiments against the brick walls, where the strikes from the Whitworth gun were much fewer than those from the Armstrong gun, not from any defect in the shells, but from a defect in the laying of the gun. All the common shells which struck the wall acted perfectly, whilst the shrapnel did quite as much as could be expected from these projectiles under the circumstances.

If there had been the same number of hits with the Whitworth as with the Armstrong shells, the effects produced upon the walls, and upon the targets behind, would have been the same or nearly so in each case.

In conclusion, I beg to assure the Committee that in offering these remarks for their consideration, my only desire is, that the shell and fuzes which I have designed for the Whitworth gun may be tested in a way to prove whether they possess those qualities which are essential to their successful employment in the field.

I have, &c.

Major-General R. Rumley,  
President of the Armstrong  
and Whitworth Committee.

E. M. BOXER,  
Supt. R.L.

Royal Hotel, Southend,  
June 16, 1864.

SIR,

It has come to my knowledge that the Boxer shells used in the experiments now in progress are differently charged for bursting at long and short distances from the targets. At the long distances the small charge is used, which merely throws out the bullets without bursting the shell or causing much dispersion. At the short distances a higher charge is used, which bursts the shells and produces many fragments and much dispersion.

In practice with time fuzes, which the present experiments are intended to represent, the variation of distance at which the shell explodes is due to the recognized irregularity of the fuze. The accident therefore of a shell bursting either too near or too distant, cannot be provided for by a previous adaptation of the charge to suit the event. By the use of screens and percussion fuzes the Committee have for convenience eliminated the uncertainty of the bursting point, and have thereby, unintentionally I believe, given Col. Boxer the opportunity of employing alternative modes of bursting his shells, which in practice would be rendered futile by the uncertainty of the fuze.

It appears to me that the shells never would be *designedly* burst at the unfavourable distances which the Committee are prescribing, but, even if any condition of service can be defined, which would render it expedient to endeavour to make the time fuze take effect at those distances, and with a variable bursting charge, it must obviously create confusion and misapprehension in the present experiments to mix up the two objects in one series.

For these reasons I consider that the results of the experiments in question are up to this point of no value as representing the effect of Col. Boxer's shell under the conditions of actual service, and I am very reluctantly obliged to request that a choice may be made between the two bursting charges used in these experiments, and that the rounds fired with the rejected charge shall be expunged from the records.

I have only to add that I communicated verbally to members of the Committee my objection to the variation of the bursting charge in the Boxer shell, the moment I had reason to suppose that such variations had been made.

I have, &c.

The Secretary, Special  
Armstrong and  
Whitworth Committee.

W. G. ARMSTRONG.

Minute Paper. 7663/219, 10/9/64.

LORD HARTINGTON,

WILL you approve of permission being given to Sir W. Armstrong to have 20 shells, of the pattern made by Col. Boxer for Mr. Whitworth, manufactured in the Royal Laboratory. It will be an interesting experiment, and I recommend it.

22/9.

(Signed) H. M.

PT. A. AND W. COM.,

WILL you give your opinion. If you see no objection the shells will be ordered.

24/9.

(Signed) H. M.

LORD DE GREY,

N, 14/9.

I SHOULD like to know the opinion of the Committee on this subject direct from themselves. I should have no objection to the experiment, if they have none, but I should wish to leave the matter entirely in their hands.

18/9/64.

(Signed) DE GREY.

D.O.,

THE Committee purposely abstained from any interference with regard to the supply of Col. Boxer's shells, as requested by Sir W. Armstrong, and only expressed their readiness to carry out the experiments in the event of Sir William Armstrong obtaining the necessary authority for the supply.

27/9/64.

(Signed) R. RUMLEY,  
M. Gen. and Pres.

LORD HARTINGTON,

THESE shells will be fired as part of the 200 rounds which the inventors are to be allowed to fire at the end of the trial with such projectiles as they may think proper, to develop the capabilities of their respective systems. As the Committee do not raise any objection, and as the time presses, perhaps you will give an early decision.

28/9.

(Signed) H. M.

The shells may be ordered.

1/10.

(Signed) N.

Colonel Boxer will be directed to make the shells, and request him to communicate with Col. Batun on the subject.

3/10.

(Signed) H. M.

SIR,

Newcastle upon Tyne, September 10, 1864.

HAVING lately applied to the Special Armstrong and Whitworth Committee for permission to fire 20 of Col. Boxer's elongated shrapnel shell from my 12-pr. shunt gun, in order to show that, apart from the question of the comparative efficacy of that shell and my own, it was equally applicable to both forms of gun, I have received a reply that the Committee have no objection. They observe, however, that it will be necessary for me to obtain the authority of the Secretary of State for this purpose, as well as to enable me to communicate with Colonel Boxer with respect to the supply.

I have the honour therefore to request that the necessary authority may be granted.

I have, &c.

(Signed) W. G. ARMSTRONG.

The Under Secretary of State,  
War Office.

SIR,

Dovercourt, August 29, 1864.

In reply to your memorandum of the 24th instant, I have the honour to state, for the information of the Armstrong and Whitworth Committee, that the principle I have adopted in the construction of the shrapnel for the Whitworth gun can be readily applied to shells for the Armstrong gun, or indeed to any system of rifled ordnance; and further, that I shall be ready to work out the details of a shrapnel for the Armstrong guns, if the Secretary of State for War wishes me to do so.

I have, &c.

Major Dyer, R.A.,  
Secretary, A. & W. Committee.

E. M. BOXER,  
Lieut.-Col., R.A.

Minute Paper. 7663/238, 27/10/64.

MY LORD, 28, Pall Mall, October 27, 1864.

I AM informed that after your Lordship's reference of Sir W. Armstrong's application for the use of my shrap-



nel shell with his shunt gun to the Armstrong and Whitworth Committee, and after their reply that they purposely declined interfering in the matter, on a renewed application by Sir W. Armstrong the desired permission has been granted. Permit me to point out that the shrapnel shell is an important part of the system of artillery with which I am competing against Sir W. Armstrong, and that to hand over the use of it to him does not seem to me to be fair treatment on the part of the War Office.

I am sure your Lordship will not consider me discourteous in saying so, for the shell stands exactly on the same footing as my case shot and rifled spheres. I have had great success with these, and should consider myself grievously injured by any act of authority which permitted Sir W. Armstrong to use them against me in this competition.

I am, &c.

The Right Honourable JOSEPH WHITWORTH.  
the Earl de Grey and Ripon,  
&c. &c. &c.

SIR,

I AM directed by the Secretary of State for War to acknowledge the receipt of your letter of the 27th instant, in which you complain that Sir W. Armstrong has been permitted to use your shell with his shunt gun in the trials conducted by the Armstrong and Whitworth Committee. His Lordship desires me to inform you that on the application of Sir W. Armstrong to be allowed to fire 20 of Colonel Boxer's elongated shrapnel shells, to show their applicability to guns of his construction, Earl de Grey and Ripon saw no reason to refuse the permission asked; but, upon receipt of the letter under acknowledgment, in which you claim the shell in question as yours, Earl de Grey and Ripon requested that Colonel Boxer should be called upon to state whether this shell was properly designated Boxer's shell; and I have to enclose you a copy of his reply.

Under these circumstances, his Lordship does not consider it would be fair to refuse to one competitor the advantage which has been allowed to the other of using the invention of a Government officer.

(Signed) J. ST. G.

Ask Colonel Boxer to state whether these elongated shrapnel shells are properly designated as his shells, or whether they are the invention of Mr. Whitworth.

28/10.

(Signed) J. ST. G.

Minute Paper. 7663/239, 29/10/64.

Immediate.

No. 1427, 72/3.

SIR,

Royal Laboratory, Woolwich, S.E.,  
October 29, 1864.

In reply to your letter of yesterday's date, 7663/238, I have the honour to inform you that the shells I am now making, at the request of the Secretary of State, for Mr. Whitworth, are properly designated "Boxer's" shells, and are not the invention of Mr. Whitworth.

These shells are precisely similar in principle to my diaphragm shrapnel shell, and the particular arrangements carried out in their construction were designated by me in 1859.

At the request of Earl de Grey and Ripon, when his Lordship was Under Secretary of State, I assisted Mr. Whitworth in perfecting his system of ordnance, in relation to fuzes and shrapnel, and I then applied the principle of construction to a shrapnel for the Whitworth gun.

Mr. Whitworth has never claimed this shell as his invention, and I am sure he has no desire to do so.

I have, &c.

The Director of Ordnance, E. M. BOXER,  
War Office. Supt. Royal Laboratory.

LORD DE GREY,

THIS is Colonel Boxer's reply. It is evident that Mr. Whitworth is in error in calling it his shrapnel shell, and he does not seem to have any just cause of complaint.

(Signed) J. ST. G.

29/10/64.

See my Minute.

(Signed) DE GREY.

31/10/64.

SIR,

War Office, December 6, 1864.

I AM directed by Earl de Grey and Ripon to acknowledge the receipt of your letter of the 24th November, in which you urge further objections to the use by Sir Wm. Armstrong, in the trials conducted by the Armstrong and Whitworth Committee, of the shrapnel shells similar in construction to those which have been fired from your guns.

The letter from Lieut.-Col. Boxer, of which a copy accompanied the letter addressed to you from this office on the 2nd November, 7663/238, shows that that officer claims the invention of this shell as his own; and Lord de Grey cannot, under these circumstances, admit any claim on your part to preclude his Lordship from making any use, required by the public service, of shells of this construction.

Lord de Grey, is, however, of opinion that the argument which you deduce from the fact that, when shells of this description were first manufactured in the Royal Laboratory in 1861 you were required to bear the expenses connected with their preparation, is entitled to weight, so far as the present competitive trials between Sir Wm. Armstrong and yourself are concerned.

His Lordship also considers that you are entitled to claim the same treatment in all respects in regard to the limit fixed for sending in ammunition for the experiments of the Armstrong and Whitworth Committee as has been accorded to Sir Wm. Armstrong, and that, consequently, if the permission to use these shells involves an extension of that limit in favour of Sir Wm. Armstrong, you may justly ask either that a similar extension should be granted to you, or that the permission given to Sir Wm. Armstrong should be withdrawn.

It would be highly undesirable indefinitely to postpone the conclusion of the inquiry with which the Armstrong and Whitworth Committee are charged by the adoption of the latter course, and Lord de Grey has determined, upon a full review of the circumstances of the case, not to allow the shrapnel shells prepared by Col. Boxer to be used with Sir Wm. Armstrong's guns in the trials before the Armstrong and Whitworth Committee.

I have, &c.

(Signed) J. ST. GEORGE, Major-General,  
J. Whitworth, Esq., Director of Ordnance.  
28, Pall Mall.

SIR,

War Office, December 6, 1864.

WITH reference to your letter of the 10th September 1864, in which you request that 20 of Col. Boxer's elongated shrapnel shell may be made in the Royal Laboratory with a view to their being fired from your 12-pr. shunt gun in the Armstrong and Whitworth competitive trials, and the reply thereto of the 3rd October, in which the permission you request is granted by the Secretary of State for War, I am directed by Earl de Grey and Ripon to inform you, that it having been brought to his notice that the shells in question cannot be supplied in accordance with the terms of the letter addressed to you on the 19th September, in which the 1st October was named as the last day on which ammunition could be received for the purposes of the competitive trial; and further, considering the fact that it was decided in 1861 that the expense of experiments carried on in perfecting the shrapnel shell for use with Mr. Whitworth's gun should be borne by that gentleman, his Lordship regrets to be obliged to withdraw the permission given for the use of the shells with your guns before the Armstrong and Whitworth Committee.

(Signed) J. ST. GEORGE, Major-General,  
Director of Ordnance.

Sir Wm. Armstrong, C.B.,  
Elswick, Newcastle-on-Tyne.

SIR,

Newcastle-upon-Tyne, October 17, 1864,

COL. BOXER, who has been authorized by the War Office to prepare 20 of his elongated shrapnel shells adapted for my 12-pr. shunt gun, has written to say that, to enable him to prepare these shells, it will be necessary for him to fire some trial ones from a shunt gun of this calibre. I shall feel obliged, therefore, if the Committee will allow him the use of the B or C 12-pr. shunt gun now in their hands, in order that he may make the necessary trials.

I have, &c.

The Secretary, Armstrong  
and Whitworth Committee. W. G. ARMSTRONG.

SIR, Bexhill, October 19, 1864.

IN your letter to me of the 17th instant you state that two different descriptions of common shell are not to be used with Mr. Whitworth's 70-pr. gun. I beg therefore to observe that the common shell now being used with that gun differs altogether in weight and dimensions from that used with the gun during 85 rounds fired in the competitive trials at Shoeburyness on the 7th and 9th ultimo and recorded by the Committee.

I have, &c.

The Secretary, Armstrong  
and Whitworth Committee. per W. G. ARMSTRONG,  
STUART RENDEL.

Minute by Committee.

Write to Mr. Rendel to say that although these rounds have been fired with a different shell, as stated by him, the Committee in authorizing the use of the shell since fired from Mr. Whitworth's gun had determined that the 85 rounds in question should be excluded from all consideration in weighing the merits of the different systems of artillery.

SIR, Newcastle-upon-Tyne, October 19, 1864.

I HAVE just heard that the Committee have put in competition 12-pr. case shot, supplied by me prior to the 1st April last, with that which has been perfected by Mr. Whitworth, assisted by the Royal Laboratory, pending the present trials, and delivered by him at a very recent period. I was led to understand that no ammunition would be received by the Committee after the 1st April, and I therefore deemed it useless to carry on experiments for the purposes of these trials with any form of projectile. I beg further to state that I have not the smallest doubt that the case shot for my guns might, if time were allowed me for experiments, be greatly increased in efficiency, and I trust it will not be assumed that the case shot delivered in April last is the best that could have been brought forward if I had been at liberty to delay its delivery until the present time.

I have, &c.

The Secretary, Armstrong  
and Whitworth Committee. W. G. ARMSTRONG.

SIR, Shoeburyness, October 26, 1864.

WITH reference to the firing which is about to take place with shot which have been subjected to rough usage, I have the honour to point out that the lead-coated projectiles underwent this treatment in association with both Mr. Whitworth's angular shot and those for the shunt gun.

It will be obvious that the effect of this treatment has been at once to damage the softer projectiles more than would have been the case had they been packed with projectiles only of the same nature, and to cushion and to that extent save from injury the harder projectiles.

I have, therefore, the honour to request that the Committee will take these circumstances into consideration, and attach a note with respect to them in their proceedings.

I have, &c.

Major Dyer, R.A. per W. G. ARMSTRONG,  
&c. &c. H. NOBLE.

SIR, Newcastle-upon-Tyne, November 1, 1864.

I HAVE to acknowledge the receipt of your letter of the 28th October, in which you state that every latitude having been afforded to the competitors, by placing at their disposal 200 additional rounds, the Committee consider I ought to have availed myself of the liberty so given in bringing forward any improved pattern of case shot which I might have to propose.

In reply, I beg leave to observe that if Mr. Whitworth's case shot had been brought forward as part of his additional rounds, and tried under his separate programme, I could have had no reason to object; but what I complained of was that case shot delivered by me before the 1st of April last, as required by the Committee, were tried by them, *competitively*, against case shot delivered by Mr. Whitworth at a much later date, and resulting from experiments made during the trials.

I have, &c.

The Secretary, Armstrong  
and Whitworth Committee. W. G. ARMSTRONG.

SIR, Newcastle-upon-Tyne, November 7, 1864.

REFERRING to your letter of the 1st instant, I beg to observe that although the Committee may have no record of my having applied to make a slight increase in the windage in the 70-pounder muzzle-loading projectiles, I feel sure that it will be in the recollection of some of the members that a verbal application to that effect was made. It was not put in writing because I was given to understand that it could not be entertained, and because I was quite aware that the rule of no alteration was at that time in full force.

I have, &c.

The Secretary, Armstrong  
and Whitworth Committee. W. G. ARMSTRONG.

SIR, Newcastle-upon-Tyne, November 17, 1864.

ON the 13th October last I addressed a letter to you, stating that it was impossible for me to acquiesce in Mr. Whitworth being allowed to use one form of common shell for range and accuracy and another for distinctive effect, unless the same privilege were extended to myself. In reply I was informed that it was a mistake to suppose that there was any intention of permitting Mr. Whitworth to use two patterns of common shell, and that in the experiments which were then forthcoming he would be confined to one.

Notwithstanding this assurance, I find that in the recent experiments at Portsmouth, to test destructive effect against the "Alfred" target ship, Mr. Whitworth has been allowed to use two forms of common shell, the one being that previously tried for range and accuracy and the other being a lengthened shell containing a greatly increased bursting charge. I can scarcely suppose that the Committee will justify this proceeding upon the ground that they do not regard their trial of Mr. Whitworth's lengthened shell as competitive with my *unlengthened* shell, for it is clear that shells fired on the same occasion and against the same object cannot fail to be generally regarded as comparative, and indicative of the relative destructiveness of Mr. Whitworth's shells and mine.

The simple fact of the case is that Mr. Whitworth has, in the course of the trials made by the Committee, been allowed to use three distinct patterns of common shell, while I have been restricted to one, and the advantage of such a latitude in Mr. Whitworth's case is too obvious to require comment.

I shall feel obliged if the Committee will favour me with an explanation of the reasons which have induced them to give this latitude to Mr. Whitworth, and have led them to depart from their announced intention of restricting him to one pattern.

Referring also to my letter of the 1st instant, I have the honour to request that you will inform me what action the Committee have taken as regards the remonstrance contained in that letter.

I have, &c.

The Secretary, Armstrong  
and Whitworth Committee. W. G. ARMSTRONG.

SIR, Shoeburyness, November 21, 1864.

I AM informed that the Committee have decided on discontinuing their experiments with live shrapnel shell from the 70-pr. in the marshes. I beg, therefore, to request that the incomplete practice in the marshes with my muzzle-loading 70-pr. may be struck out of the Committee's records, inasmuch as there can be no practice in the marshes with the other 70-pr. with which the former practice can be compared.

I may observe also that in the practice with my muzzle-loading 70-pr. referred to above, the wrong fuze was employed, and that the bursting charge used was that intended for naval service only, and not what I should prescribe for land service. I may further add, that in recording the effect of the 70-pr. shrapnel shell a rule appears to have been followed in the marshes different to that adopted subsequently on the sands. On the marshes direct hits were not taken into account.

I have, &c.

The Secretary, Armstrong  
and Whitworth Committee. W. G. ARMSTRONG,  
per H. NOBLE.



SIR, Newcastle-upon-Tyne, December 16, 1864.  
I HAVE the honour to acknowledge the receipt of your letter (No. 79) of the 28th ulto., from which I collect that the Committee are under the impression that it was open to me up to the 1st October last to supply new patterns of ammunition. The Committee will recollect that the competitors were desired in April last to select patterns from each of the various kinds of ammunition, and were informed that no deviation from those patterns would be permitted. No communication to the contrary was ever made to me, and I have never felt myself at liberty to bring forward any modified form of projectile to be used competitively in the present trials.

I do not wish in any degree to restrict the investigations of the Committee respecting the various forms of ammunition which have been submitted for trial with the Whitworth guns, and only ask that experiments made with projectiles recently supplied by or for Mr. Whitworth may not be deemed competitive with projectiles supplied by me prior to April last. To this end I would beg leave to suggest that all such experiments might properly be embodied in the Appendix, so as to be kept distinct from the competition.

With this suggestion I leave the matter in the hands of the Committee.

I have, &c.

The Secretary, Armstrong and Whitworth Committee. W. G. ARMSTRONG.

Elswick Ordnance Works.

SIR, Newcastle-upon-Tyne, May 29, 1865.  
WITH reference to your request that we should furnish to you for the information of the Armstrong and Whitworth Committee, the actual cost of rifling the projectiles for the 12-pr. muzzle-loading shunt gun, we have the honour to enclose herewith a statement showing the exact cost of the process as carried out in the presence of the Committee.

This statement is marked A, and with regard to it we beg to remark that the Committee will observe that the value of the raw material is only 2s. 4d., while the cost of converting it into the form of studs is 3s. 9½d. This high rate must, however, be regarded as due to the imperfect process which has as yet been adopted, and, as an illustration of the very great economy which may be expected to result when the manufacture is properly established, we may adduce the case of the process of making lead bullets in the Royal Arsenal, where the cost of labour is only 1d. per 800 bullets. Zinc studs could of course be made in an analogous manner.

We also enclose a statement marked B, showing the actual cost of rifling 100 12-pr. segment shell when the holes are drilled and under-cut, and when copper studs are

used. We may observe that this statement represents the exact cost for the last supply of segment shell made for the Committee.

We have, &c.

The Secretary, Armstrong and Whitworth Committee. W. G. ARMSTRONG & Co.

A.

PRESENT COST of rifling 100 12-pr. segment shell, showing the total labour and material expended in fitting them with studs suitable for the shunt form of rifling, viz.:—

|                                            | s. | d.   |
|--------------------------------------------|----|------|
| Material                                   | -  | 2 4  |
| Labour, preparing material                 | -  | 1 8  |
| Labour, making studs (piece price)         | -  | 2 1½ |
| Labour, putting in studs (piece price)     | -  | 3 0  |
| Labour, pressing through die (piece price) | -  | 0 8½ |
| Total                                      | -  | 9 10 |

W. G. ARMSTRONG & Co.

B.

COST of rifling 100 12-pr. segment shell (holes drilled and undercut, and copper studs used), showing the total labour and material expended in fitting them with studs suitable for the shunt form of rifling, viz.:—

|                                                 | s. | d.   |
|-------------------------------------------------|----|------|
| Material in the form of studs                   | -  | 15 0 |
| Drilling and under-cutting shells (piece price) | -  | 1 7½ |
| Labour, putting in studs (piece price)          | -  | 2 0  |
| Labour, pressing through die (piece price)      | -  | 0 8½ |
| Total                                           | -  | 19 4 |

W. G. ARMSTRONG & Co.

44, Charlton Street, Manchester,  
June 1, 1865.

SIR, REFERRING to the interview which Mr. Whitworth had with the President on Monday last, we now beg to forward you the accompanying Schedules of the prices at which we are supplying our patent rifled steel guns and ammunition. We may add that these prices might be considerably reduced if we had to supply either the guns or ammunition in large quantities.

We are, &c.

The Whitworth Company, Limited.  
Major Dyer, R.A.,  
109, Victoria Street,  
Westminster, S.W. W. J. HOYLE,  
Secretary.

44, Charlton Street, Manchester,  
1st June 1865.

# SPECIFICATION of the Whitworth Patent Muzzle-loading Tempered Steel Rifled Guns, Appurtenances, and Ammunition.

|                                                                          | 1-Pr.   | 3-Pr.   | 4-Pr.   | 6-Pr.   | 9-Pr.   | 12-Pr.  |
|--------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|
| <i>Field Guns.</i>                                                       | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| Muzzle-loading guns - - - price each                                     | 40 0 0  | 55 0 0  | 70 0 0  | 90 0 0  | 110 0 0 | 120 0 0 |
| <i>Appurtenances.</i>                                                    |         |         |         |         |         |         |
| Shot extractor, rammer, bristle sponge, and wad hook - - - price per set | 1 12 6  | 2 4 6   | 2 16 6  | 3 9 0   | 4 3 0   | 4 15 6  |
| <i>Ammunition.</i>                                                       |         |         |         |         |         |         |
| Solid shot - - - - - price per 100                                       | 1 1 0   | 2 16 6  | 3 7 0   | 5 0 0   | 7 2 0   | 10 0 0  |
| Rifled spheres - - - - - "                                               | 1 1 0   | 1 1 0   | 1 5 0   | 2 2 0   | 2 18 6  | 3 15 0  |
| Common shell - - - - - "                                                 | —       | —       | —       | 10 0 0  | 12 10 0 | 15 0 0  |
| Shrapnel shell - - - - - "                                               | —       | —       | —       | 26 5 0  | 30 0 0  | 35 0 0  |
| Cartridge bags for powder charges - - - - - "                            | 0 7 6   | 0 10 0  | 0 12 6  | 0 15 0  | 0 17 6  | 1 0 0   |
| Lubricating wads - - - - - "                                             | 0 4 0   | 0 8 0   | 0 12 0  | 0 14 0  | 0 17 0  | 1 0 0   |
| Friction tubes - - - - - "                                               | 0 16 0  | 0 16 0  | 0 16 0  | 0 16 0  | 0 16 0  | 0 16 0  |
| Wood sabots - - - - - "                                                  | 0 10 0  | 0 12 0  | 0 14 0  | 0 16 0  | 0 17 0  | 0 18 0  |
| Time fuzes - - - - - "                                                   | —       | —       | —       | 12 10 0 | 12 10 0 | 12 10 0 |

The Secretary, Special Armstrong and Whitworth Committee,  
109, Victoria Street, Westminster, S.W.

The Whitworth Company, Limited.  
W. J. HOYLE, Secretary.

44, Charlton Street, Manchester,  
1st June 1865.

SPECIFICATION of the Whitworth Patent Muzzle-loading Tempered Steel Rifled Guns, Appurtenances, and Ammunition.

|                                                                            | 32-Pr.         | 5½-Inch.       | 7-Inch.        |
|----------------------------------------------------------------------------|----------------|----------------|----------------|
| <i>Naval Guns.</i>                                                         | <i>£ s. d.</i> | <i>£ s. d.</i> | <i>£ s. d.</i> |
| Muzzle-loading guns - - - - price each                                     | 475 0 0        | 700 0 0        | 1,350 0 0      |
| <i>Appurtenances.</i>                                                      |                |                |                |
| Slot extractor, rammer, bristle sponge, and wad hook - - - - price per set | 6 14 6         | 8 2 6          | 9 12 0         |
| <i>Ammunition.</i>                                                         |                |                |                |
| Solid shot - - - - price per 100                                           | 23 7 0         | 50 0 0         | 95 0 0         |
| Rifled spheres - - - - "                                                   | 7 10 0         | 15 0 0         | 30 0 0         |
| Common shell - - - - "                                                     | 37 10 0        | 62 10 0        | 115 0 0        |
| Shrapnel shell - - - - "                                                   | 90 0 0         | 150 0 0        | 250 0 0        |
| Flat-front steel shell for penetrating armour plates each                  | 4 10 0         | 5 10 0         | 8 10 0         |
| Cartridge bags for powder charges - - - - per 100                          | 1 15 0         | 2 10 0         | 3 10 0         |
| Lubricating wads - - - - "                                                 | 1 10 0         | 3 0 0          | 6 0 0          |
| Friction tubes - - - - "                                                   | 0 16 0         | 0 16 0         | 0 16 0         |
| Wood sabots - - - - "                                                      | 1 5 0          | 1 10 0         | 1 15 0         |
| Time fuzes - - - - "                                                       | 12 10 0        | 12 10 0        | 12 10 0        |

The Secretary, Special Armstrong and Whitworth Committee,  
109, Victoria Street, Westminster, S.W.

The Whitworth Company, Limited.  
W. J. HOYLE, Secretary.

SIR, Newcastle-upon-Tyne, April 8, 1865.

WITH respect to the prices at which the Elswick Company are manufacturing muzzle-loading guns I have the honour to inform you that they are now tendering for, and supplying the same, at rates varying as under, according to terms of payment, number ordered, and other conditions of contract, viz. :—

|              |          |       |
|--------------|----------|-------|
|              | £        | £     |
| 12-prs. from | 135 to   | 150   |
| 40-prs. "    | 315 to   | 385   |
| 70-prs. "    | 550 to   | 650   |
| 150-prs. "   | 945 to   | 1,100 |
| 300-prs. "   | 1,620 to | 1,800 |
| 600-prs. "   | 3,700 to | 4,000 |

The above prices include sights and browning.

These guns are steel-barrelled coil guns. The 70-prs. are of a rather stronger and heavier pattern than the muzzle-loading 70-prs. supplied to the Committee.

I have, &c.

The Secretary, Armstrong and Whitworth Committee. W. G. ARMSTRONG.

penses, if made in large quantities, would be as follows, viz. :—

|                                                              |                |
|--------------------------------------------------------------|----------------|
|                                                              | Per 100.       |
| Shells, segment, for Armstrong 12-pr. B.-L. gun              | £ s. d. 11 1 0 |
| Bursters for do. - - - - "                                   | 1 11 9         |
| Fuzes, E., time - - - - "                                    | 4 13 11        |
| " percussion - - - - "                                       | 3 6 6          |
| Shells, Boxer's shrapnel, for 12-pr. Whitworth gun - - - - " | 13 19 9        |
| Bursters for do. - - - - "                                   | 0 6 8          |
| Fuzes, time, for do. - - - - "                               | 2 8 8          |
| " concussion do. - - - - "                                   | 2 11 2         |

No segment shells for 12-pr. Armstrong muzzle-loading guns have been made in this department.

I am, &c.

Major Dyer, R.A., Secretary, E. M. BOXER,  
Armstrong and Whitworth Committee, Supt. R.L.  
109, Victoria Street, S.W.

IR, Newcastle-upon-Tyne, April 8, 1865.

I HAVE the honour to give below the prices at which the Elswick Company have been and are supplying the under-mentioned projectiles for muzzle-loading guns, the prices varying according to the numbers required and other conditions of the contract, viz. :—

|                             |          |           |
|-----------------------------|----------|-----------|
|                             | s. d.    | s. d.     |
| 12-pr. { segment shell from | 2 10 to  | 4 0 each. |
| { common do. "              | 2 7 to   | 3 6 "     |
| 40-pr. { segment shell "    | 8 6 to   | 10 9 "    |
| { common do. "              | 7 6 to   | 9 0 "     |
| 70-pr. { segment shell "    | 13 6 to  | 18 0 "    |
| { common do. "              | 12 0 to  | 15 0 "    |
| 150-pr. { segment shell "   | 27 0 to  | 35 0 "    |
| { common do. "              | 23 5 to  | 30 0 "    |
| 300-pr. { segment shell "   | 50 0 to  | 60 0 "    |
| { common do. "              | 44 0 to  | 50 0 "    |
| 600-pr. { segment shell "   | 108 0 to | 120 0 "   |
| { common do. "              | 90 0 to  | 100 0 "   |

I have, &c.

The Secretary, Armstrong and Whitworth Committee. W. G. ARMSTRONG.

Royal Laboratory, Woolwich, S.E.,  
April 10, 1865.

WITH reference to your letter of 25th ult. I beg to state, for the information of the Armstrong and Whitworth Committee, that the cost of the under-mentioned articles for labour and materials, exclusive of any contingent ex-

July 20, 1865.

MEMORANDUM for the SECRETARY of the ARMSTRONG and WHITWORTH COMMITTEE.

SAMPLES taken from the steel barrels of the 12-pr. competitive guns, which were tested to destruction, have been submitted to analysis, and the following are the per-centage results obtained :—

|                       |           |          |              |             |                    |
|-----------------------|-----------|----------|--------------|-------------|--------------------|
|                       | Sul-phur. | Silicon. | Phos-phorus. | Manga-nese. | Cobalt and Nickel. |
| Whitworth Gun -       | 0·013     | 0·098    | 0·251        | 0·086       | 0·081              |
| Armstrong Shunt Gun - | 0·016     | 0·087    | 0·159        | 0·061       | 0·06               |
| Armstrong B.-L. Gun - | 0·032     | 0·021    | 0·108        | 0·075       | 0·044              |

F. A. ABEL,  
Chemist of the War Department.

SIR, April 26, 1864.

As there appears to be some doubt whether both Armstrong and Whitworth guns are sighted in the same manner, I have the honour to request, by direction of the Committee, that you will be good enough to send a competent person to Shoeburyness on Friday next to verify the sights of these 12-pr. guns.

I am, &c.

Col. Campbell, R.A., (Signed) H. DYER, Major R.A.  
Supt. Royal Gun Factory. Secretary.



MAJOR DYER,

As this service is pressing, I have put it in hand; but it will be necessary for me to be furnished with an authority to quote for the expenditure, and also to know to what vote it is to be charged.

(Signed) H. CAMPBELL,  
Colonel R.A.

R. G. F.—29/4/64.

SUPT. ROYAL GUN FACTORY,

I HAVE applied to the D.O. for authority.

(Signed) H. DYER,  
Major R.A.

2/5/64.

SIR,

Royal Gun Factory, May 2, 1864.

MAJOR DYER having made an application by letter, dated 26th April, for a competent person to attend at Shoeburyness to verify the sights of the Armstrong and Whitworth guns under trial by the Armstrong and Whitworth Committee, I have the honour to report that a competent person of this department has attended and examined the guns, and that he reports as follows:—

"No. 264, Whitworth Muzzle-loader,

"Radius from hind to foresight - - 38·45

"Length of scale for 10 degrees - - 6·8

"When laid point blank by the sight on the right of gun it requires a packing on the trunnion sight of ·03 of an inch, equal about 3 minutes of permanent elevation, this is the side used in firing, but on trying the left side it was found to require the same packing on the tangent scale, thus giving about 3 minutes depression, showing the sight ring not to have been put on level.

"I would also beg to remark that this sight is not the one verified before the guns left the Royal Arsenal, which one I obtained from Major Dyer, and tried on; in doing so I found the cascable or breech piece, on which the sight ring is fixed, had been removed, and not put up again to the same mark at which it had originally been, and which I consider was the cause of the error.

"No. 52, Armstrong Muzzle-loader,

"Radius from hind to foresight - - 26"

"Length of scale for 10 degrees - - 4·58

"When put at point blank this gun required a packing of ·03 of an inch under the tangent sight, giving a depression of about 3½ minutes, making a difference of 6½ minutes between this gun and No. 264. This error was caused by the wrong trunnion sight having been taken into use with this gun, and a piece of oakum being placed between the top of the collar and the shoulder of the sight to keep it fast in its place; on trying the right trunnion sight I found the collar to have started up, so as to show a depression of about one minute.

"No. 38, Breech-loading Armstrong,

"Radius from hind to foresight - - 30·8

"Length of scale for 10 degrees - - 5·43

"This gun when put at point blank required a packing of ·01 of an inch under the tangent sight equal to about one minute of depression, which is to be accounted for by the block through which the tangent scale works having gone down in firing, which causes a difference between this gun and No. 264 of about four minutes."

I have, &c.

The Director of Ordnance,  
War Office, Pall Mall.

JOHN ANDERSON,  
Assistant Superintendent.

*Extract from Letter from Mr. Whitworth dated April 8, 1865.*

With regard to the destruction of my 12-pounder gun, I consider that it would have stood many more rounds if the firing had been continued on the Monday, when it had already stood 29 rounds more than the shunt gun, and 39 more than the Armstrong breech-loader. But owing to the gun being exposed to 6° of frost during the night its state and condition were entirely changed. The gun should have been fired the following morning with single charges until it had attained about the same temperature as it was on the preceding evening.

Minute 3/9.

War Office,

January 9, 1863.

SIR,

WITH reference to the evidence you gave before the Committee I am directed to forward the amended tabular form, with the request you will be good enough to fill up the several columns and add any other information that may suggest itself to you, respecting the guns you propose to submit to the Committee.

I am also directed to request you will be good enough to forward working drawings and specifications of the guns and ammunition with an estimate of the cost of each article, to enable the Committee to obtain the sanction of the Secretary of State for War for carrying on the necessary experiments.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Secretary.  
Sir W. Armstrong, C.B.,  
8, Great George Street, S.W.

Minute 3/9.

War Office,

January 9, 1863.

SIR,

REFERRING to my letter, Minute 2/1, dated 6th January, I am directed by the Committee to request you will substitute the annexed form, and be good enough to fill up the several columns with the information connected with the guns and ammunition you propose to submit to the Committee, and that you will also forward as early as possible detailed working drawings and specifications, accompanied by an estimate of the cost of the guns and ammunition you propose, that no time may be lost in obtaining the sanction of the Secretary of State for War, for carrying on the necessary experiments.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Secretary.

P.S. The Committee request you will be good enough to prepare the drawings of guns ½ scale (3 inches to a foot). The projectiles full scale. The fuzes twice actual size.

Joseph Whitworth, Esq.,  
28, Pall Mall, London.

Minute 7/1.

109, Victoria Street, Westminster, S.W.,

January 19, 1863.

SIR,

WITH reference to the enclosed tabular statement, which you supplied in compliance with the request of the Committee contained in my letter Minute 3/9, dated January 9, 1863, the Committee request you will be good enough to inform them whether this form contains the details of every nature and description of ordnance and ammunition you propose to submit, and if not, that you will add those you have omitted, heading the form as follows:—

"Tabular statement of all the different descriptions of guns and ammunition proposed by Mr. Whitworth," and that you will authenticate it by your signature.

The Committee also request you will inform them which of these guns are now ready for experiment, and on what day all or any of them can be handed over complete.

As the manufacture of large quantities of ammunition required for experiments must of necessity require considerable time, the Committee beg that you will forward at your earliest convenience the detailed working drawings, specifications, and patterns of every description of ammunition you propose, that no time may be lost in commencing the manufacture at the Royal Laboratory, Woolwich.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Joseph Whitworth, Esq.,  
28, Pall Mall, London. Secretary.

Minute 7/1.

109, Victoria Street, Westminster, S.W.,

January 19, 1863.

SIR,

IN acknowledging the receipt of your letter of the 17th instant, containing a description of the guns and ammunition shown in the enclosed tabular form, and the drawings which accompanied it, the Committee request you will be good enough to inform them whether this form contains the details of every description of ordnance and ammunition you propose to submit, and if not, that you will add those that you have omitted, heading the form as follows:—

"Tabular statement of all the different descriptions of ordnance and ammunition proposed by Sir William Armstrong:"

And that you will authenticate it by your signature.

The Committee also request you will inform them which of these guns are ready for experiment, and on what day all or any of them can be handed over complete.

As the manufacture of large quantities of ammunition required for experiment must of necessity require considerable time, the Committee beg you will forward at your earliest convenience the detailed working drawings, specifications and patterns of every description of ammunition you propose, that no time may be lost in commencing the manufacture at the Royal Laboratory, Woolwich.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Sir W. Armstrong, C.B., Secretary.  
Newcastle-on-Tyne.

109, Victoria Street, Westminster, S.W.,  
January 26, 1863.

SIR, THE Committee are anxious to make themselves acquainted with the different processes in operation at Elswick for the manufacture of your ordnance and ammunition. They therefore propose, if convenient to you, to visit the Elswick Ordnance Works on Wednesday, 4th February, at such hour in the morning as may be most agreeable to you.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Sir W. Armstrong, C.B., Secretary.  
Elswick Ordnance Works.

109, Victoria Street, Westminster, S.W.,  
January 26, 1863.

SIR, THE Committee are anxious to make themselves acquainted with the manufacture of your ordnance and ammunition, they are desirous therefore of visiting your works at Manchester on Friday, 6th February, at any hour in the morning that will be most convenient to you.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Joseph Whitworth, Esq., Secretary.  
Manchester.

109, Victoria Street, Westminster, S.W.,  
January 26, 1863.

SIR, THE Committee request you will lose no time in forwarding the drawings, &c. requested in my letter of the 19th instant, more particularly those of the 12-pounder and 70-pounder guns and ammunition you propose, as they have determined on commencing the experiments with these guns and wish to have the carriages ordered as soon as possible; they also request you will be good enough to return the proof sheet of your evidence at your earliest convenience.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Joseph Whitworth, Esq., Secretary.  
28, Pall Mall, London.

109, Victoria Street, Westminster, S.W.,  
January 27, 1863.

MY LORD, THE Committee having now arrived at a stage of their inquiry at which it seems desirable to carry on some experiments to test the relative values of the ordnance and ammunition proposed by Sir W. Armstrong and Mr. Whitworth, I have the honour to request your sanction to the following orders being sent:—

To Sir W. Armstrong to supply:—

One breech-loading 12-pounder gun complete, 200 segment shell, 200 common shell, 600 solid shot, 200 bursters, 400 time fuzes, 400 concussion fuzes.

One muzzle-loading 12-pounder gun complete, 200 segment shell, 200 common shell, 600 solid shot, 200 bursters, 400 time fuzes, 400 concussion fuzes.

One 70-pounder breech-loading gun complete, 100 segment shell, 200 common shell, 500 solid shot, 100 special shot and 100 special shell for penetrating armour plates, 300 time fuzes, 300 concussion fuzes.

One 70-pounder muzzle-loading gun complete, 100 segment shell, 200 common shell, 500 solid shot, 100 special shot, and 100 special shell for penetrating armour plates, 300 time fuzes, 300 concussion fuzes.

To Mr. Whitworth to supply:—

One muzzle-loading 12-pounder gun complete, 200 shrapnel shell, 200 common shell, 600 solid shot.

One muzzle-loading 70-pounder gun complete, 100 shrapnel shell, 200 common shell, 500 solid shot, 100 special shot and 100 special shell, for penetrating armour plates.

As Mr. Whitworth proposes to use fuzes similar to the service fuze for smooth-bore guns, these can be supplied from the Royal Laboratory, Woolwich.

I have also to request you will direct the Principal Superintendent of Stores, Woolwich, to comply with such requisitions from the Committee for stores, ammunition, &c. as may be necessary to enable them to carry on their experiments.

I have, &c.

(Signed) R. RUMLEY,  
Major-General and President.

The Under Secretary of State,  
War Office, Pall Mall.

109, Victoria Street, Westminster, S.W.,  
February 2, 1863.

SIR, IN compliance with the request contained in your letter No. 3, dated 29th January 1863, the Committee will postpone their visit to your works until the conclusion of the experiments.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Joseph Whitworth, Esq., Secretary.  
Manchester.

109, Victoria Street, Westminster, S.W.,  
February 9, 1863.

SIR, ADVERTING to your Minute M./252 on duplicate demand, R. 1, 2/2/63, there appears to be some mistake in ordering the guns mentioned in your letter M./243. The only demand yet made for guns, &c. is R. 1, 2/2/63, which only specifies guns of two calibres, viz., 12- and 70-pounders, as, however, all the guns specified in your letter, except the three brass Whitworth guns, will probably eventually be required by the Committee for experimental purposes, their being supplied at once will prevent delay when they are required.

With reference to the three brass guns (Whitworth) to be supplied by the Royal Gun Factory, I have communicated with the Director of Ordnance, as it may probably be the intention to carry on experiments with guns made both of brass and homogeneous metal.

I agree with the suggestion made in paragraph 2, Minute M./252, and I will therefore substitute a complete demand for R. 1, 2/2/63.

In answer to paragraph 3, the Committee request that the whole of the Armstrong projectiles, fuzes, and bursters, should be supplied by the Elswick Ordnance Company.

That the whole of the Whitworth projectiles should be made at Manchester.

And that in both cases they should be inspected by the Inspector of Artillery, for which purposes patterns have been demanded, R. 7, R. 10, 9/2/63.

The cartridges for all guns, the Committee request, may be made in the Royal Laboratory specially for the experiments; that the same number of cartridges for the same nature of Armstrong and Whitworth gun be made out of each barrel of powder used, and that each cartridge may be marked with the brand of the powder.

The Committee request that Mr. Whitworth's wish to have his fuzes made in the Royal Laboratory be complied with; the pattern fuze therefore demanded in R. 10, 9/2/63, after having been compared with the one for the Committee, may be handed over to the Superintendent, Royal Laboratory, to govern his supply.

The Committee have not yet determined what proof they propose the guns should undergo. I will therefore communicate further with you in reference to the concluding paragraph of your Minute M./252.

I have, &c.

(Signed) H. DYER, Captain R.A.,  
The Principal Superintendent of Stores, Secretary.  
Royal Arsenal, Woolwich.

109, Victoria Street, Westminster, S.W.,  
February 17, 1863.

SIR, THE Committee beg to inform you that Sir W. Armstrong has submitted a 20-pounder gun, weight 12½ cwt., length without fittings 66½ inch, as a shell gun for field service, to replace the 24-pounder howitzer formerly used in a field battery. They request you will inform them whether you consider it necessary that such a description



of gun should accompany your 12-pounder gun in the field, and if so, they request you will supply them with a drawing and description on a tabular form, similar to that which accompanied my letter Minute 3/9, dated January 9, 1863, of the gun you propose to submit to compete with this 20-pounder.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
J. Whitworth, Esq., Secretary.  
28, Pall Mall, London.

109, Victoria Street, Westminster, S.W.,  
February 24, 1863.

SIR, THE Committee having been informed by the Under Secretary of State for War that two 12-pounder breech-loading Armstrong guns have been ordered in Royal Gun Factory on 7663/14, 17/1/63, and one 12-pounder breech-loading Armstrong gun from Elswick Ordnance Company on 7663/6, 10/1/63, they beg you will inform them whether these are the guns you propose to submit for the experiments in compliance with their demands on the Principal Superintendent of Stores, Woolwich, R. 12, 10/2/63, and R. 20, 16/2/63, or whether they are to be considered as additional. They also request you will inform them whether you have any objection to take three of the 70-pounder breech-loading guns under orders from Elswick Ordnance Company on contract, as the 70-pounders demanded on the requisition quoted above.

I have, &c.

(Signed) H. DYER, Captain R.A.,  
Sir W. Armstrong, C.B., Secretary.  
Elswick Ordnance Works,  
Newcastle-on-Tyne.

109, Victoria Street, Westminster, S.W.,  
February 24, 1863.

SIR, The Committee having been informed by the Under Secretary of State for War that three brass 12-pounder muzzle-loading Whitworth guns have been ordered from the Royal Gun Factory on 80/W./729, 23/12/63, they request you will inform them whether you propose to submit these guns to them for their experiments; they also beg you will inform them whether the three homogeneous metal 12-pounder guns ordered from the Manchester Ordnance Company on 80/W./743, 10/1/63, and 7350/7992, 2/12/62, are those which you propose to submit in compliance with the covering order to my letter R. 18, 16/2/63, or whether these guns are to be considered as additional.

I have, &c.

(Signed) H. DYER, Captain R.A.,  
J. Whitworth, Esq., Manchester. Secretary.

109, Victoria Street, Westminster, S.W.,  
March 6, 1863.

SIR, THE Committee having considered your letter, dated February 26, authorize you to make one muzzle-loading 70-pounder gun of 75 cwt., that being the weight of Mr. Whitworth's gun. It would, however, be more in accordance with the plan of experiments the Committee have adopted if *all three* of the muzzle-loading 70-pounders were so altered, and they would accordingly wish this to be done, provided you do not attach any special importance to a trial of the muzzle-loading light gun of 61 cwt.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Sir W. Armstrong, C.B., Secretary.  
Newcastle-on-Tyne.

109, Victoria Street, Westminster, S.W.,  
March 11, 1863.

SIR, THE Committee beg to acknowledge the receipt of your letter, dated March 9, 1863, and in answer beg to inform you that for the present they will confine their experiments to the 70-pounders of 75 cwt. (muzzle-loaders) to compare with the 75-cwt. muzzle-loading gun proposed by Mr. Whitworth, as they consider it would only complicate the experiments to carry them on with two muzzle-loaders of the same calibre, but of different weights, more particularly as they will be able to obtain sufficient data concerning the light 70-pounder from the breech-loading guns you propose.

They request you will forward a tracing of the 75 cwt. 70-pounder muzzle-loader to enable a carriage to be constructed for it.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Sir W. Armstrong, C.B., Secretary.  
Newcastle-on-Tyne.

109, Victoria Street, Westminster, S.W.,  
March 30, 1863.

SIR, THE Committee request you will inform them when the delivery of your field guns and ammunition will take place. By a letter received to-day from Mr. Whitworth, it appears he proposes to deliver some of his field guns in 10 days.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Sir W. Armstrong, C.B., Secretary.  
Newcastle-on-Tyne.

109, Victoria Street, Westminster, S.W.,  
March 31, 1863.

SIR, ADVERTING to your letter informing the Committee that some of your field guns would be ready for delivery in 10 days, and requesting to know when the carriages would be ready, I have the honour to inform you that the carriages for the field guns will be completed early next week, as far as they can be without the guns. Owing to the unusual position of the elevating screw, it is not considered advisable to fit it to the carriage before the arrival of the guns; this, however, can easily be done in two days.

The Committee beg again to urge the necessity of your forwarding them patterns in duplicate of your cartridges and wads, with specifications to guide the manufacture in the Royal Laboratory, as until these are received the manufacture cannot be commenced. As very large quantities of ammunition will be required, and as very great care will be required in its manufacture to prevent the possibility of any mistakes, the Committee beg there may be as little delay as possible in forwarding the patterns.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Joseph Whitworth, Esq., Secretary.  
28, Pall Mall, London.

109, Victoria Street, Westminster, S.W.,  
April 2, 1863.

SIR, ADVERTING to the concluding paragraph of your letter of the 1st, I have the honour to inform you that the Committee propose to apply to you for all projectiles to be used at the forthcoming experiments in compliance with a request contained in Mr. Whitworth's letter of the 24th of January. The whole of the cartridges, however, they proposed to have manufactured in the Royal Laboratory to insure uniformity of powder.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
William Hulse, Esq., Secretary.  
Manchester Ordnance Company.

109, Victoria Street, Westminster, S.W.,  
April 13, 1863.

SIR, THE Committee beg to acknowledge the receipt of the cartridges and wads forwarded from the Manchester Ordnance Company to guide the manufacture of these articles in the Royal Laboratory, Woolwich. Although it is departing from their instructions to offer either suggestions or advice on anything that may be submitted to them for trial, they would beg you to reconsider the matter before coming to the determination to have your cartridges and wads made similar to the patterns you have supplied. The Committee are most anxious that the forthcoming experiments should be as complete and exhaustive as possible, and with this view, they wish, if possible, to prevent any errors either in the construction or manufacture of the ammunition which might produce advantageous or disadvantageous results on either side, and thus render the trials nugatory as far as the systems of rifling are concerned.

As the success of a gun depends so much on the ammunition, and as there are so many minor details that should receive consideration before any particular pattern is adopted, I think it would save time and useless correspondence if you would favour me with a personal interview either here or in Manchester. I should then be able to point

out to you the sources from whence you could obtain the information on this subject derived from a long series of experiments, and it would then be optional whether you accepted these results or whether you would prefer to adhere to your original plans. I am, &c.

(Signed) H. DYER, Captain R.A.,  
William Hulse, Esq., Secretary.  
Manchester Ordnance Company.

109, Victoria Street, Westminster, S.W.,  
April 23, 1863.

SIR,  
IN compliance with the desire of Mr. Whitworth the Committee request you will be good enough to prepare patterns of the under-mentioned articles to be submitted for his approval:—

|                                   |   |        |   |
|-----------------------------------|---|--------|---|
| Cartridge and wad for 12-pr. gun. |   |        |   |
| Common shell                      | " | "      | " |
| Shrapnel                          | " | "      | " |
| Cartridge and wad                 | " | 70-pr. | " |
| Common shell                      | " | "      | " |
| Shrapnel                          | " | "      | " |
| Fuze                              | " | "      | " |

I have, &c.

(Signed) H. DYER, Captain R.A.,  
Colonel Boxer, R.A., Secretary.  
Superintendent Royal Laboratory, Woolwich, S.E.

109, Victoria Street, Westminster, S.W.,  
April 24, 1863.

SIR,  
REFERRING to your note of the 28th March 1863, stating that "some of the guns would be ready in eight or 10 days," the Committee request you will be good enough to inform them whether you have yet delivered the guns at Woolwich, as they have not received any notification of their arrival.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Joseph Whitworth, Esq., Secretary.  
Manchester.

109, Victoria Street, Westminster, S.W.,  
June 5, 1863.

MY LORD,  
I HAVE the honour to draw your lordship's attention to the little progress the Committee have been able to make in determining the questions submitted for their consideration in the instructions which accompanied War Office letter 7663/1, dated 1st January 1863, and to request your Lordship's further instructions.

On the 6th January Mr. Whitworth was examined before the Committee and stated, in answer to question 66, that "a 12-pr. gun, then at Manchester, would be finished " in a short time;" and in answer to question 64, that "the ammunition was then ready for experiment."

In a letter dated 17th February 1863, Mr. Whitworth states "the guns will be completed as early as possible and " will probably be as follows, viz.:—

" The 3 12-pr. guns in 3, 4, and 6 weeks.  
" 3 70-pr. " " 3, 6, " 8 "

On the 28th March Mr. Whitworth again writes to say "some of the guns will be ready in eight or 10 days."

On the 24th April the Committee communicated with Mr. Whitworth with reference to his note of the 28th March, requesting to be informed if the guns had yet been delivered; they have received no answer to this letter, nor have they received any notification of the arrival of the guns.

The Armstrong field guns have been proved and are ready for delivery.

I have, &c.

(Signed) R. RUMLEY, Major-General,  
The Under Secretary of State, President.  
War Office, Pall Mall.

109, Victoria Street, Westminster, S.W.,  
June 12, 1863.

SIR,  
I HAVE this day forwarded by passenger train a box containing two 70-pr. cartridges, 12 lbs. each, with Boxer's lubricator attached, and two 12-pr. cartridges, 2 lbs. each, with lubricators. These cartridges, &c. have been made in

the Royal Laboratory and are now submitted for your approval. Should they be in every respect suitable for your guns and such as you would wish to submit for the forthcoming experiments, the Committee request you will seal or otherwise mark each cartridge and lubricator and return them with as little delay as possible, that they may serve as patterns to govern the manufacture of your ammunition in the Royal Laboratory.

The Committee beg again to urge upon you the necessity of hastening the delivery of your guns, as it is of the utmost importance that the experiments should be proceeded with as soon as possible.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
J. Whitworth, Esq., Secretary.  
Manchester Ordnance Company.

109, Victoria Street, Westminster, S.W.,  
June 22, 1863.

SIR,  
IN reply to your letter of the 17th, the Committee beg to inform you that the 100 12-pr. cartridges you require for experiment shall be provided from the Royal Laboratory with as little delay as possible. With reference to the latter part of your letter, in which you state that the machinery necessary for the "manufacture of the larger " guns will be ready in six weeks," the Committee beg you will not delay the delivery of the 12-pr. guns until the completion of the 70-prs., as the experiments with the field guns will necessarily occupy some considerable time, and they are anxious to proceed with these experiments with as little delay as possible.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
J. Whitworth, Esq., Secretary.  
Manchester.

109, Victoria Street, Westminster, S.W.,  
November 13, 1863.

SIR,  
THE Principal Superintendent of Stores, Woolwich, has informed me that he has this day received an invoice for 600 solid shot from the Manchester Ordnance Company, but that no mention is made either of the common or shrapnel shell. I must remind you that the preliminary experiments mentioned in your letter of the 4th inst. must be delayed until the arrival of both the common and shrapnel shell, as without them the limbers for your guns cannot be completed, and until they are none of the guns can be sent to Shoeburyness for the experiments you desire.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
J. Whitworth, Esq., Manchester. Secretary.

109, Victoria Street, Westminster S.W.,  
November 17, 1863.

MY LORD,  
I AM directed by the Armstrong and Whitworth, Committee to request you will give them information on the following points, to guide them in considering the value of some proposals submitted by Sir W. Armstrong.

1st. What is the greatest weight and length admissible, and what the most convenient for a cupola gun, a pivot gun, and a broadside gun?

I have, &c.

(Signed) H. DYER, Captain R.A.,  
Secretary.

The Secretary, Admiralty.

109, Victoria Street, Westminster, S.W.,  
November 24, 1863.

SIR,  
IN reply to your letter of the 21st, informing me that 200 shrapnel shells had been forwarded for Colonel Boxer's preliminary experiments, and that Mr. Whitworth proposed to supply 200 shot and 200 long common shell, and 200 additional shrapnel for the Committee's experiments, and requesting a covering order for them, I have the honour to inform you that the Committee have no power to authorize any ammunition other than that already demanded for their experiments. In compliance with a wish expressed by Mr. Whitworth, the Committee proposed to make a supplementary demand for the few rounds necessary to determine the length of fuze and ele-



vation for the shrapnel shell, but they do not consider that 200 will be required for the purpose. The Committee again beg to urge the delivery of the ammunition for the field guns without delay, as until the whole of it has been delivered they are determined not to commence any experiments.

I have, &c.  
(Signed) H. DYER, Captain R.A.,  
Secretary.

W. Hulse, Esq., Manchester Ordnance Company.

Royal Arsenal, Woolwich, S.E.,  
November 27, 1863.

SIR, I AM directed to request you will forward one 12-pounder Whitworth gun and carriage, side arms, &c., to Shoeburyness for the use of Colonel Boxer, R.A., together with such Whitworth ammunition as he may consider necessary for his experiments.

I am, &c.  
(Signed) H. DYER, Captain R.A.,  
Secretary.

The Principal Superintendent of Stores, Woolwich.

Royal Arsenal, Woolwich, S.E.,  
November 27, 1863.

SIR, I AM directed by the Committee to inform you that a Whitworth 12-pounder and carriage has been sent to Shoeburyness to enable you to carry on the necessary experiments to ascertain the elevation and length of fuze necessary for the shrapnel shell you have designed for Mr. Whitworth's gun. Colonel Taylor has been communicated with, and will afford the necessary assistance.

I am, &c.  
(Signed) H. DYER, Captain R.A.,  
Secretary.

Colonel Boxer, R.A., Superintendent  
Royal Laboratory.

109, Victoria Street, Westminster, S.W.,  
December 3, 1863.

SIR, THE Committee having determined to carry on experiments with the 70-pounders at the same time as with the field guns, request you will be good enough to deliver your 70-pounder guns and ammunition as soon as possible.

Should no unforeseen delays occur, the experiments are fixed for the middle of January.

I am, &c.  
(Signed) H. DYER, Captain R.A.,  
Secretary.

Sir W. Armstrong, C.B.,  
Elswick Ordnance Company.

109, Victoria Street, Westminster, S.W.,  
December 3, 1863.

SIR, THE Committee would feel much obliged if you would inform them when you think the preliminary experiments to determine the length of fuze, &c., for the shrapnel shell you have designed for Mr. Whitworth's gun will be completed, and what number of rounds will be sufficient for the purpose.

I am, &c.  
(Signed) H. DYER, Captain R.A.,  
Secretary.

Colonel Boxer, R.A., Superintendent  
Royal Laboratory.

109, Victoria Street, Westminster, S.W.,  
December 3, 1863.

SIR, IN reply to your letter dated October 27, proposing a 6½-ton gun for a broadside gun and one of 12 tons for cupolas, I am directed by the Committee to inform you that they consider the 12-pounders and 70-pounders they have ordered are sufficient to show the relative values of the systems proposed by Mr. Whitworth and yourself, in field and heavy ordnance, they must therefore for the present decline to order any other guns, as they hope to obtain all

the necessary information of both systems without incurring any further expense.

I am, &c.  
(Signed) H. DYER, Captain R.A.,  
Secretary.

Sir W. Armstrong, C.B., Elswick  
Ordnance Company.

109, Victoria Street, Westminster, S.W.,  
December 3, 1863.

MY LORD, I AM directed by the Committee to request authority to order 500 solid shot and 200 segment shell for each nature of field gun in addition to the number already sanctioned, and as so much delay has already been caused owing to the first order having only just been complied with, the Committee request your Lordship's sanction to any future order being made the subject of a contract with such penalties as you may consider necessary to ensure the delivery within the specified time.

I have, &c.  
(Signed) H. DYER, Captain R.A.,  
Secretary.

The Right Honourable the Secretary  
of State for War, War Office.

109, Victoria Street, Westminster, S.W.  
December 16, 1863.

SIR, As the 70-pounder gun and ammunition, which you informed the Committee at your interview on the 2nd inst., had left your works for delivery at Woolwich has not yet been received there, the Committee think it desirable you should make some inquiries on the subject, as they are anxious to have everything ready for the experiments at the middle of January.

I am, &c.  
(Signed) H. DYER, Captain, R.A.,  
Joseph Whitworth, Esq., Manchester  
Ordnance Company, Manchester. Secretary.

109, Victoria Street, Westminster, S.W.,  
December 23, 1863.

SIR, I AM directed by the Committee to request you will forward your 70-pounder muzzle and breech-loading guns with their ammunition to Woolwich with as little delay as possible, as it is definitely settled that the experiments will be carried on simultaneously with the 12- and 70-pounders, and commence as soon after the middle of January as possible.

I am, &c.  
(Signed) H. DYER, Captain R.A.,  
Sir W. Armstrong, C.B., Elswick  
Ordnance Company. Secretary.

109, Victoria Street Westminster, S.W.,  
January 7, 1864.

SIR, I AM directed to inform you that the experiments with the Armstrong and Whitworth field guns will commence on Thursday, the 14th January next, at 9 a.m., at the practice range, Shoeburyness.

The experiments with the 70-pounder guns, which were to take place at the same time, are postponed until further notice.

I am, &c.  
(Signed) H. DYER, Captain, R.A.,  
Sir W. G. Armstrong, C.B., Elswick  
Ordnance Works, Newcastle-on-Tyne. Secretary.

109, Victoria Street, Westminster, S.W.,  
January 7, 1864.

SIR, I AM directed to inform you that the experiments with the Armstrong and Whitworth field guns will take place at the practice range, Shoeburyness, on Thursday the 14th inst., at 9 a.m.

The experiments with the 70-pounders, which were to have been carried on at the same time, are postponed, pending the delivery of your 70-pounder guns and ammunition.

I am, &c.  
(Signed) H. DYER, Captain, R.A.,  
Joseph Whitworth, Esq., Manchester  
Ordnance Company, Manchester. Secretary.

109, Victoria Street, Westminster, S.W.,  
January 7, 1864.

SIR, I AM directed to inform you that the experiments with the Armstrong and Whitworth field guns will commence at 9 a.m. on Thursday the 14th January, at the practice range, Shoburness, as determined at a meeting of the Committee on December 2nd, 1863. The experiments with the 70-pounders are unavoidably postponed until the delivery of Mr. Whitworth's guns and ammunition.

I enclose a copy of the report on the Southport range.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
W. Pole, Esq., 3, Storey's Gate, Secretary.  
Westminster.

Also to—

J. Penn, Esq.  
Colonel Simmons, R.E.  
Colonel Taylor, R.A.  
Colonel Ormsby, R.A.

109, Victoria Street, Westminster, S.W.,  
January 8, 1864.

SIR, THE Committee having determined to postpone the experiments fixed for the 14th inst., as they think it possible that that day might be inconvenient to you, request you will be good enough to name some time between two early dates when it will be convenient for you to commence the experiments, that they may fix the day that will best suit yourself and Mr. Whitworth.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Sir W. Armstrong, C.B., Secretary.  
Newcastle-on-Tyne.

Also to—

J. Whitworth, Esq.

109, Victoria Street, Westminster, S.W.,  
January 19, 1864.

SIR, I AM directed to request you will favour the Committee with a reply to their letter of the 8th inst. requesting you to name a time between two early dates at which you you will be ready to commence the experiments at Shoburness.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Joseph Whitworth, Esq., Manchester Secretary.  
Ordnance Company, Manchester.

109, Victoria Street, Westminster, S.W.,  
January 25, 1864.

SIR, THE delays which have occurred in the delivery of your guns and ammunition having caused the experiments to be so repeatedly deferred the Committee are most desirous of fixing a date on which the experiments may with certainty be commenced; for this purpose it is essential that you should inform them when the whole of your guns and ammunition (both 12- and 70-pounders) will be delivered at Woolwich, as the Committee have decided not to commence any of the experiments until the whole of the guns and ammunition have been received at Woolwich, so as to ensure that no change will be made during the experiments when partial results have been obtained.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Joseph Whitworth, Esq., Secretary.  
Manchester Ordnance Company, Manchester.

109, Victoria Street, Westminster, S.W.,  
January 25, 1864.

SIR, THE Committee being desirous of visiting your works at Manchester request you will be good enough to name a day for the purpose, if it is agreeable to you that they should do so.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Joseph Whitworth, Esq., Secretary.  
Manchester Ordnance Company, Manchester.

109, Victoria Street, Westminster, S.W.,  
February 6, 1864.

SIR, IN reply to your letter 7663, 108, dated January 30, 1864, I have the honour to inform you that the Committee commenced their proceedings on the 5th January, 1863, and in compliance with their instructions proceeded to examine both Mr. Whitworth and Sir W. Armstrong to ascertain what description of ordnance and ammunition they were prepared to submit, and at the conclusion of the examination requested these gentlemen to submit a tabular form embodying their views regarding guns and ammunition. These tabular forms will be found pages 129, 130, 131 in the Appendix to the Blue Book, copies of which have been forwarded to the War Office.

From the Ordnance enumerated in these tables the Committee selected the 12- and 70-pounders as types of the field and garrison or naval gun being guided in their selection by the fact of these guns most nearly corresponding in weight and calibre in the two systems, and, therefore, the most suitable for instituting a comparison as to the relative value of the systems proposed by Sir W. Armstrong and Mr. Whitworth, and also because Mr. Whitworth stated in his evidence, in answer to question 66, that he had a 12-pounder gun, which would be finished in a short time; and in answer to question 61, that the ammunition was ready to commence the experiments.

On the 27th January 1863 the Committee requested the Secretary of State for War to authorize them to order the following guns and ammunition—

From Sir W. Armstrong.

1 12-pounder M.L. gun.  
1 12-pounder B.L. gun.  
1 70-pounder M.L. gun.  
1 70-pounder B.L. gun.

With 1,000 rounds of ammunition per gun.

From Mr. Whitworth.

1 12-pounder M.L. gun.  
1 70-pounder M.L. gun.

and 1,000 rounds of ammunition per gun. Mr. Whitworth declined to supply breech-loading guns.

Having received authority 7663/30, 4/2/63, a detailed demand dated 10/2/63 was made on the Principal Superintendent stores, Woolwich, for the supply of these stores.

As the instructions directed the Committee to inquire into the manufacture of the guns and ammunition, they signified their wish to Sir W. Armstrong and Mr. Whitworth, by letter dated 26/1/63, to visit their works, that they might make themselves acquainted with the various processes of manufacture pursued. On the 29/1/63 Sir W. Armstrong informed the Committee that he would be happy to receive them at the Elswick Ordnance Company's works, and explains the manufacture of his guns, &c.; by a letter of the same date Mr. Whitworth states that he will be happy to receive the Committee, but would prefer doing so after the experiments. The Committee, therefore, visited Elswick on the 4th February, and subsequently the Royal Gun Factory and Royal Laboratory at Woolwich, but were obliged to postpone their visit to Manchester.

The Committee continued to take all the evidence they could obtain bearing on their inquiry, and concluded this portion of their labours on the 26th February, 1863; the whole of the evidence thus obtained will be found in the Blue Book.

As the Committee considered that delays might arise if only one gun of each nature were ordered, should any accident happen during the experiments, thought it desirable to order three guns of each nature.

Authority having been obtained the orders were given to Sir W. Armstrong and Mr. Whitworth, coupled with a request that they would state when they would be delivered. Mr. Whitworth, in a letter dated February 17th, 1863, states the probable time of delivery to be as follows:—

3 12-pounder guns in 3, 4, and 6 weeks.  
3 70-pounder guns in 3, 6, and 8 weeks

Sir W. Armstrong replied that he would deliver them as soon as possible.

On the 30th March 1863 a further communication was made to Sir W. Armstrong and Mr. Whitworth to ascertain the probable time of the delivery of the guns.

Sir W. Armstrong replied by letter dated April 4th, 1863, that his guns would be ready by the end of April.

Mr. Whitworth replied by letter dated 31st March 1863, that some of his guns would be ready in 10 days; as the



guns were not delivered the Committee drew Mr. Whitworth's attention to the fact by letter dated April 24th, 1863; no reply was received to this.

The Committee reported on the 5th June 1863 to the Secretary of State for War, and on the 12th June again urged Mr. Whitworth to deliver his guns; in reply, dated June 17th, he states that he cannot get the metal he considers requisite for his heavy guns until the manufacturers erect suitable machinery for the purpose; this he expects will be ready in six weeks. The Committee, therefore, by letter dated June 22nd, 1863, urged him not to delay the delivery of his 12-pounder guns, as they are anxious to commence the experiments.

On the 4th September Mr. Whitworth informed the Committee that his rifled guns would be ready in three or four weeks.

The Armstrong guns were proved on the following dates, but were retained at Newcastle in compliance with a request to that effect made by Sir W. Armstrong, as the Committee could not decide on the time for commencing the experiments until the delivery of Mr. Whitworth's guns:—

|                        |   |         |
|------------------------|---|---------|
| No. 49 70-pounder B.L. | { | 11/3/63 |
|                        |   | 30/3/63 |
| " 55 " "               |   | 5/6/63  |
| " 56 " "               |   | 17/6/63 |
| " 58 " M.L.            |   | 28/5/63 |
| " 59 " "               |   | 29/5/63 |
| " 60 " "               | { | 19/6/63 |
|                        |   | 9/7/63  |
| " 38 12-pounder B.L.   |   | 12/3/63 |
| " 53 " "               |   | 6/5/63  |
| " 61 " "               |   | 19/5/63 |
| " 51 " M.L.            |   | 30/4/63 |
| " 52 " "               |   | 6/5/63  |
| " 57 " "               |   | 9/5/63  |

The Whitworth 12-pounder guns were delivered as follows:—

|                         |          |
|-------------------------|----------|
| No. 246 12-pounder M.L. | 15/10/63 |
| " 251 " "               | 29/10/63 |
| " 253 " "               | 29/10/63 |

Their proof, however, was delayed until 4/11/63, owing to the proof shot not having been delivered with the guns.

On the 2nd December 1863 the Committee met to fix the date for the experiments; Mr. Whitworth attended this meeting, and urged that to save time it would be desirable to carry on the experiments with the 12- and 70-pounders at the same time; the Committee agreed to this, and fixed the middle of January 1864 for the experiments. Mr. Whitworth concurring in this arrangement, Sir W. Armstrong was therefore requested to deliver all his guns and ammunition, and completed the deliveries 11/1/64.

Mr. Whitworth delivered his ammunition as follows:—

|                             |         |
|-----------------------------|---------|
| 12-pounder—200 common shell | 1/12/63 |
| " 600 solid shot            | 6/11/63 |

and forwarded 200 shrapnel shell to be filled in the Royal Laboratory; these latter have, however, not yet been handed over to the Committee, as it appears Mr. Whitworth wishes to make some alteration in their exterior dimensions.

None of the 70-pounder guns or ammunition have yet been received.

As the Committee were anxious to suit the convenience of Sir W. Armstrong and Mr. Whitworth, they communicated with them on January 11, 1864, requesting them to name their own day for the experiments.

Sir W. Armstrong replied that he would be happy to attend any day the Committee might appoint. Mr. Whitworth, by letter dated January 20, states he will be ready any day between the 1st and 15th February.

On the 25th January 1864 the Committee met to make all final arrangements previous to commencing the experiments, and then received a letter from Sir W. Armstrong protesting against the experiments being proceeded with until Mr. Whitworth had delivered all his guns and ammunition, as he considered it was unfair that Mr. Whitworth should have all the advantage of the progressive improvement in the manufacture of metals while he was prevented by having complied with the request of the Committee and delivered all his guns and ammunition. The Committee so entirely concurred in the justice of this protest that they have postponed the experiments until Mr. Whitworth delivers his guns and ammunition.

On the 4th February 1864 the Committee visited Mr. Whitworth's works, and received an assurance from him in person and by letter dated February 5, 1864, that he will

deliver the whole of his 12 and 70-pounder guns, solid shot and common shell by the 14th March next.

From the foregoing detail of the proceedings of the Committee, it is evident that the cause of the delay that has occurred is due to the non-delivery of the Whitworth guns and ammunition.

I have, &c.

(Signed) R. RUMLEY, Major-General,

The Under Secretary of State, President.  
War Office.

109, Victoria Street, Westminster, S.W.,

Sir, March 1, 1864.

I AM directed by the Committee to forward you a copy of a letter received from the War Office in reference to the competitive trials of the Armstrong and Whitworth guns, and at the same time to beg that your deliveries on the 14th March next may be complete in every respect and on no account be delayed beyond that date, or it will be impossible to insure the guns and ammunition reaching Shoeburyness before the 1st April.

I am, &c.

(Signed) H. DYER, Captain R.A.,

J. Whitworth, Esq., Secretary.  
Manchester Ordnance Company, Manchester.

Royal Arsenal, Woolwich, S.E.,

Sir, March 11, 1864.

To insure your ammunition being delivered in conformity with your wishes I am directed to request you will be good enough to supply me with the following information respecting the cartridges you propose using:—

For 12-pounder gun.

Length  
Diameter  
Charge.

Description of dimensions of lubricator.

Do you propose to vary your cartridge for the different natures of projectiles?

For 70-pounder gun.

Length  
Diameter  
Charge.

Description and dimensions of lubricator.

Do you propose to vary your cartridge for the different natures of projectiles; if so, would you be good enough to give the same information respecting each description of cartridge you propose to employ.

I have, &c.

(Signed) H. DYER, Captain R.A.,

Joseph Whitworth, Esq., Secretary.  
Manchester Ordnance Company, Manchester.

Royal Arsenal, Woolwich, S.E.,

March 28, 1864.

PRINCIPAL SUPERINTENDENT OF STORES,

THE Committee having consented to Sir W. Armstrong and Mr. Whitworth making any changes they may think proper in the ammunition, &c. delivered for the competitive trials, request you will receive any stores supplied for the purpose until the 1st April next, after which date no further change can be permitted.

I am, &c.

(Signed) H. DYER, Captain R.A.,  
Secretary.

Royal Arsenal, Woolwich, S.E.,

Sir, March 29, 1864.

As it is absolutely necessary that the field guns with their ammunition should leave for Shoeburyness to-morrow afternoon, I have the honour to request you will be good enough to hand over to the Principal Superintendent of Stores the following ammunition and stores for the Whitworth 12-pounder guns:—

|                           |   |   |   |     |
|---------------------------|---|---|---|-----|
| Segment shell             | - | - | - | 100 |
| Common "                  | - | - | - | 100 |
| Fuzes "                   | - | - | - | 200 |
| Cartridges                | - | - | - | 200 |
| Fuze implements, sets     | - | - | - | 3   |
| Bursting for common shell | - | - | - | 100 |

I am, &c.

(Signed) H. DYER, Captain R.A.,

Colonel Boxer, R.A., Secretary.  
Superintendent Royal Laboratory.

109, Victoria Street, Westminster, S.W.,  
March 31, 1864.

SIR, IN reply to your letter of the 30th March 1864, the Committee request you will be good enough to fit up a fuze box for the approval of Mr. Whitworth; they request you will demand any stores necessary for this purpose from the Principal Superintendent of Stores, Woolwich.

I am, &c.  
(Signed) H. DYER, Captain R.A.,  
Secretary.

The Superintendent Royal Laboratory.

109, Victoria Street, Westminster, S.W.,  
March 31, 1864.

SIR, OWING to the changes that have taken place in the fuzes supplied for the forthcoming experiments, the patterns are now obsolete; the Committee therefore propose to return such patterns, and have determined to request both Mr. Whitworth and yourself to select one article of each nature, from the ammunition now supplied, which will be sealed to govern future supplies; these will be inspected and passed by the Inspector of Ordnance in strict accordance with the limits of error allowed in similar stores for the service.

I am, &c.  
(Signed) H. DYER, Captain R.A.,  
Sir W. Armstrong, C.B., Secretary.  
9, Hyde Park Street, London, S.W.

109, Victoria Street, Westminster, S.W.,  
March 31, 1864.

SIR, OWING to the changes that have taken place in the ammunition supplied for the experiments, the patterns formerly supplied are useless, the Committee therefore propose to return them to you, and to request you will select one article of each nature from the ammunition now supplied to serve as a pattern to govern future supplies, which will in future be inspected and passed by the Inspector of Ordnance in strict accordance with the limits of error allowed in similar stores for the service.

I am, &c.  
(Signed) H. DYER, Captain R.A.,  
Joseph Whitworth, Esq., Secretary.  
Manchester.

Royal Arsenal, Woolwich, S.E.,  
April 2, 1864.

SIR, IN reply to your letter 1/4/64, I am directed to inform you that the Committee concur with you in the desirableness of having the assistance of the man who packed the ammunition, and also request you will be good enough to detail some one competent to instruct two or three non-commissioned officers and men in the management of the shrapnel shell and fuzes you have proposed for Mr. Whitworth's guns.

I am, &c.  
(Signed) H. DYER, Captain R.A.,  
Secretary.

The Superintendent Royal Laboratory.

109, Victoria Street, Westminster, S.W.,  
April 8, 1864.

SIR, IN reply to your letter of the 7th inst., the Committee beg to inform you that they regard the three guns on the same terms as if supplied by three different persons, and that they propose to record results accordingly. The fact therefore of Sir W. Armstrong having two guns is immaterial.

I am, &c.  
(Signed) H. DYER, Captain R.A.,  
Joseph Whitworth, Esq., Secretary.  
Shoeburyness.

SIR, Shoeburyness, April 26, 1864.

IN making the parallelograms of error for the different ranges the Committee propose that each competitor shall be allowed to strike out any two shots from the 20 rounds of solid shot at each range, and one shot from each range of common and segment shell.

They further agree that each competitor shall have the option of signing the range tables. I have the honour to request you will favour the Committee with any remarks you may wish to make on the above proposals.

I am, &c.  
(Signed) H. DYER, Captain R.A., and Major,  
Joseph Whitworth, Esq., Secretary.  
Manchester Ordnance Company, Manchester.

SIR, Shoeburyness, April 26, 1864.

IN making the parallelograms of error for the different ranges the Committee propose that each com-

petitor shall be allowed to strike out any two shots from the 20 rounds of solid shot at each range, and one shot from each range of common and segment shell.

They further agree that each competitor shall have the option of signing the range tables.

I have the honour to request you will favour the Committee with any remarks you may wish to make on the above proposals.

I am, &c.  
(Signed) H. DYER, Captain R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.

109, Victoria Street, Westminster, S.W.,  
May 2, 1864.

SIR, IN reference to your proposal to cancel that portion of the programme for Thursday next relating to common case, I am directed to inform you that the Committee have decided on not making any alteration in the programme. Should you object to this course your protest will be recorded on the Committee minutes, and the experiments will be carried on with segment and shrapnel shell as common case.

The experiments will commence at 11 a.m.

I have, &c.  
(Signed) H. DYER, Captain R.A., and Major,  
Joseph Whitworth, Esq., Secretary.  
Manchester Ordnance Company, Manchester.

SIR, Shoeburyness, May 6, 1864.

I AM directed by the President of the Committee to acknowledge the receipt of your letter 17/26/2, 29/4/64, and to inform you that it has been submitted for the consideration of the Committee.

I have, &c.  
(Signed) H. DYER, Captain R.A., and Major,  
Colonel Boxer, R.A., Secretary.  
Superintendent Royal Laboratory.

SIR, Shoeburyness, May 19, 1864.

I AM directed to inform you that the Committee are prepared to grant, on application, any number of rounds you may consider requisite for the purpose of showing any merits your system may possess. They do not wish to restrict you to any particular charge or projectile, but they request you will forward them at your earliest convenience a programme showing in what manner you propose to expend this ammunition, and the number of rounds you will require.

The results will be recorded.

I am, &c.  
(Signed) H. DYER, Captain R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.

SIR, Shoeburyness, May 19, 1864.

I HAVE the honour to inform you that the Committee are prepared to grant any number of rounds you may consider requisite for the purpose of showing any merits your system may possess. They do not wish to restrict you to any particular charge or projectile, but they request you will forward them at your earliest convenience a programme showing in what manner you propose to expend this ammunition, and the number of rounds you will require.

The results of this firing will be recorded.

I am, &c.  
(Signed) H. DYER, Captain R.A., and Major,  
J. Whitworth, Esq., Secretary.  
Shoeburyness.

SIR, Shoeburyness, June 6, 1864.

I HAVE the honour to forward herewith a copy of the rectangles of the practice with the 12-pounder competitive guns, together with the formula used in computing them. As however some errors may have occurred the Committee request you will satisfy yourself of their correctness. Should they not hear to the contrary on or before the 17th June next they will assume that you are satisfied, and hand them over to the printer for publication.

These rectangles are to be considered confidential.

I am, &c.  
(Signed) H. DYER, Captain R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.

SIR, Shoeburyness, June 6, 1864.

I HAVE the honour to forward herewith a copy of the rectangles of the practice with the 12-pounder competitive guns, together with the formula used in computing them. As however some errors may have occurred, the Committee request you will satisfy yourself of the correctness of these documents.



Should they not hear to the contrary on or before Friday, June 17, they will assume that you are satisfied, and hand them over to the printers for publication.

These rectangles are to be considered confidential.

I am, &c.

(Signed) H. DYER, Captain R.A., and Major,  
J. Whitworth, Esq., Secretary.  
Shoeburyness.

SIR, Shoeburyness, June 6, 1864.

IN reply to your letter of the 6th instant I am directed by the Committee to inform you that as soon as they had observed the defect you complain of in the 12-pounder muzzle-loading cartridges they at once communicated with the Superintendent of the Royal Laboratory, who stated in reply that "the cartridges to which you refer were manufactured in strict accordance with the dimensions laid down, and the difficulty now experienced in loading must be due to the cartridges having become enlarged in packing or in travelling to Shoeburyness."

The Committee beg to draw your attention to the fact that as far back as March 1863 they requested you would supply patterns and specifications to guide the manufacture of your ammunition in the Royal Laboratory, and that any misunderstanding that may have arisen respecting the dimensions of the cartridges now being supplied is due solely to the request of the Committee not having been complied with.

The Committee are most anxious to meet your views in every possible way as regards the supply of the ammunition, which must necessarily be made in the Royal Laboratory, but not only are the difficulties of manufacture greatly increased, but the Committee are unable to check any errors of manufacture owing to their being unprovided with either patterns or specifications to guide them in inspecting this ammunition.

In reply to the concluding paragraph of your letter the Committee will make a note of all abnormal circumstances which have caused delay in the various trials for rapid firing.

I have, &c.

(Signed) H. DYER, Captain R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.  
Newcastle-on-Tyne.

SIR, Shoeburyness, June 6, 1864.

ADVERTING to a demand made on the Principal Superintendent of Stores at Woolwich, dated April 19, 1864, for detailed working drawings and specifications of your guns and ammunition supplied for the competitive trials, I am directed by the Committee to request you will supply these drawings and specifications with as little delay as possible, as the Committee propose at an early date to enter into the question of cost and manufacture.

I have, &c.

(Signed) H. DYER, Captain R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.  
Newcastle-on-Tyne.

SIR, Shoeburyness, June 6, 1864.

ADVERTING to a demand made on the Principal Superintendent of Stores, Woolwich, dated April 19, 1864, for detailed working drawings and specifications of your guns and ammunition supplied for the competitive trials, I am directed by the Committee to request you will supply these drawings and specifications with as little delay as possible, as the Committee propose at an early date to enter into the questions of cost and manufacture.

I have, &c.

(Signed) H. DYER, Captain R.A., and Major,  
Joseph Whitworth, Esq., Secretary.  
Manchester Ordnance Company, Manchester.

SIR, Shoeburyness, June 2, 1864.

I AM directed by the Committee to acknowledge the receipt of your letter of this day's date, by which they are informed that the three 70-pounder breech-loading guns supplied by you to the Committee for experiment, and which the Committee imagined were identical in every respect, are in fact three different guns, the construction of each of which varies from that of the others.

The object of the Committee being to test the principle upon which your guns are constructed, I am to request you to inform them which of the three guns described in your letter is that with which you desire the Committee to experiment to test your principle of construction against that on which Mr. Whitworth's guns are constructed.

I am, &c.

(Signed) H. DYER, Captain R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.  
Shoeburyness.

SIR, Shoeburyness, June 9, 1864.

THE Committee beg you will be good enough to deliver to the Principal Superintendent of Stores, with as little delay as possible, as much as possible of the ammunition now under orders, as the experiments are being delayed.

I am, &c.

(Signed) H. DYER, Captain R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.  
Newcastle-on-Tyne.

SIR, Shoeburyness, June 9, 1864.

THE Committee beg you will be good enough to forward to the Principal Superintendent of Stores, Woolwich, with as little delay as possible, as much of the Armstrong and Whitworth Committee ammunition now under orders as possible, as the experiments are being delayed.

I am, &c.

(Signed) H. DYER, Captain R.A., and Major,  
J. Whitworth, Esq., Secretary.  
Manchester Ordnance Company, Manchester.

SIR, Shoeburyness, June 10, 1864.

As a difference of opinion between the competitors regarding the amount of elevation given to their guns by the quadrant has arisen, the Committee have requested the man sent from the Royal Gun Factory to sight the 70-pounder guns to remain at Shoeburyness to adjust the quadrants and direct me to obtain your sanction to retain the Whitworth sighting gauges and straight edge at Shoeburyness until the conclusion of the experiments connected with range and accuracy.

I am, &c.

(Signed) H. DYER, Captain R.A., and Major,  
Colonel Campbell, R.A., Secretary.  
Superintendent Royal Gun Factory.

Shoeburyness, June 13, 1864.

PRINCIPAL SUPERINTENDENT OF STORES,

By a telegram received from Sir W. Armstrong and Co., it appears that the firm have received no official order for the supply of 200 segment shell and percussion fuzes for breech-loading and muzzle-loading 12-pounder Armstrong guns. The demand was made on you, dated May 20, 1864; would you be good enough to send the official order.

To prevent delay in carrying on the experiments the Committee have directed Sir W. Armstrong and Co. to deliver 50 segment shell for each gun at Shoeburyness, and the remainder to you with as little delay as possible.

Would you forward to Shoeburyness as opportunities offer, all the projectiles delivered for the Committee. I will inform you as soon as the magazine accommodation will admit of receiving any more cartridges.

(Signed) H. DYER, Captain R.A., and Major,  
Secretary.

The Principal Superintendent of Stores,  
Royal Arsenal, Woolwich.

SIR, Shoeburyness, June 22, 1864.

I AM directed to inform you that the Committee desire to receive any observations you may wish to make on the records of the practice within three working days after the day on which the practice took place.

I am, &c.

(Signed) H. DYER, Captain R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.  
Shoeburyness.

SIR, Shoeburyness, June 22, 1864.

I AM directed to inform you that the Committee desire to receive any observations you may wish to make on the records of the practice within three working days after the day on which the practice took place.

I am, &c.

(Signed) H. DYER, Captain R.A., and Major,  
J. Whitworth, Esq., Secretary.  
Shoeburyness.

SIR, Shoeburyness, June 24, 1864.

THE Committee will be happy to receive any suggestions you may consider desirable with respect to the best method of arriving at the actual strength and endurance of the competitive 12-pounder guns.

I am, &c.

(Signed) H. DYER, Captain R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.  
Shoeburyness,  
And J. Whitworth, Esq.

MY LORD, Shoeburyness, June 28, 1864.

I HAVE the honour to inform you that the Armstrong and Whitworth Committee have been obliged to discontinue the experiments with the 12-pounder competitive guns until their demands for a further supply of ammunition have been complied with.

I have, &c.

(Signed) R. RUMLEY, Major-General,  
President.

The Right Hon. Earl de Grey and Ripon,  
Secretary of State for War,  
War Office.

SIR, Shoeburyness, July 1, 1864.

IN reply to your letter of the 20th of June, I am desired by the Committee to inform you that their instructions are to examine and report upon different descriptions of guns and ammunition proposed and brought forward by Sir W. Armstrong and Mr. Whitworth; although they are perfectly aware that you are preparing the shells and fuzes for the Whitworth guns, they are not authorized to consider you as a competitor in the experiments they are making. The Committee communicated their programmes daily to the two competitors, and suggest that you should take measures to obtain your information from Mr. Whitworth.

I am, &c.

(Signed) H. DYER, Captain R.A., and Major,  
Colonel Boxer, R. A., Secretary.  
Superintendent Royal Laboratory,  
Woolwich.

SIR, Shoeburyness, July 1, 1864.

MR. WHITWORTH having applied to the Committee to be allowed to fire eight steel shell as part of the 200 rounds sanctioned by the Committee for the 70-pounder additional experiments, I am directed to request you will inform me whether you wish also to fire additional steel shell from your 70-pounder gun, as it is necessary to obtain authority to order these special projectiles.

I am, &c.

(Signed) H. DYER, Captain, R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.  
Shoeburyness.

SIR, Shoeburyness, July 1, 1864.

I AM directed by the Committee to inform you that they will apply to the Secretary of State for War for authority to order eight steel shells as requested in your letter dated June 30, 1864.

I am, &c.

(Signed) H. DYER, Captain R.A., and Major,  
J. Whitworth, Esq., Shoeburyness. Secretary.

SIR, Shoeburyness, July 6, 1864.

THE Committee request that in future you will be good enough to communicate with them preparatory to making any change in the pattern of stores supplied by the Royal Laboratory for their use, as they cannot receive any stores not previously submitted for their approval.

I am, &c.

(Signed) H. DYER, Captain R.A., and Major,  
J. Whitworth, Esq., Shoeburyness. Secretary.

109, Victoria Street, Westminster, S.W.,  
July 25, 1864.

THE Committee request you will be good enough to inform them on what date you will complete the whole of the orders you now have for ammunition for their experiments, including the common case for both 12- and 70-pounders.

I have, &c.

(Signed) H. DYER, Captain R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.  
Newcastle-on-Tyne.

109, Victoria Street, Westminster, S.W.,  
July 25, 1864.

THE Committee request you will be good enough to inform them on what date you will complete the whole of the orders you now have for ammunition for their experiments, including the common case for both 12- and 70-pounders.

I have, &c.

(Signed) H. DYER, Captain R.A., and Major,  
J. Whitworth, Esq., Secretary.  
Manchester Ordnance Company, Manchester.

SIR, Shoeburyness, August 2, 1864.

THE Committee begs to acknowledge the receipt of your letter N° 7663/194, 27th July, informing them that the Secretary of State for War approves of their being adjourned until the receipt of the whole of the ammunition now ordered, and to acquaint you that no time has hitherto been lost by the Committee in carrying on the experiments, and the sole cause of their application for an adjournment was to ensure the delivery of the ammunition demanded on May 20 and June 7 last. As soon as these demands shall have been complied with, they will be prepared to proceed with the trials for endurance, &c.

I have, &c.

(Signed) R. RUMLEY, Major-General,  
The Director of Ordnance, President.  
War Office.

MY LORD, Woolwich, August 22, 1864.

I have the honour to report that, in compliance with your Lordship's directions, the Committee was adjourned until the whole of the ammunition should have been received. They re-assembled to-day to make arrangements for resuming their experiments, trusting that both Sir W. Armstrong and Mr. Whitworth would complete the deliveries as they had promised by the 23rd instant. I regret, however to inform your Lordship that as the ammunition as

ARMSTRONG.

|          |             |             |       |
|----------|-------------|-------------|-------|
|          | 70-pounder. | 12-pounder. |       |
| C. shell | 300         | -           |       |
| S. shell | 1,000       | -           | 1,300 |
| Shot     | 1,750       | -           | 1,286 |

WHITWORTH.

|          |             |             |     |
|----------|-------------|-------------|-----|
|          | 70-pounder. | 12-pounder. |     |
| C. shell | 55          | -           |     |
| S. shell | 500         | -           | 350 |
| Shot     |             |             |     |

per margin is still due the Committee are not able to resume their experiments. Letters have been addressed to both Sir W. Armstrong and Mr. Whitworth, urging them in the strongest manner to deliver their ammunition without delay.

I have, &c.

(Signed) R. RUMLEY, Major-General,  
Earl de Grey and Ripon, President.  
Secretary of State for War.

SIR, Woolwich, August 27, 1864.

THE Committee beg you will not omit to deliver the common case for both your 12- and 70-pounder guns, at the same time as the other ammunition now in course of delivery.

I am, &c.

(Signed) H. DYER, Captain, R.A., and Major,  
J. Whitworth, Esq., Secretary.  
Manchester Ordnance Company, Manchester.

SIR, Shoeburyness, Sept. 13, 1864.

THE Committee have addressed a letter to the Secretary of State for War informing him of the amount of ammunition still undelivered, and requesting his sanction to decline to receive any ammunition which is not delivered at Woolwich by noon on October 1, 1864, I am directed to give you this information that you may make arrangements for supplying what is still deficient, a list of which is annexed.

I am further directed to inform you that this applies also to the ammunition you propose to deliver for your 12- and 70-pounder programmes.

I am, &c.

(Signed) H. DYER, Captain R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.  
Newcastle-on-Tyne.

|                                              |           |       |           |           |
|----------------------------------------------|-----------|-------|-----------|-----------|
|                                              | Still due | Shot. | C. Shell. | S. Shell. |
| B.-L. 70-pounder                             | 586       |       | 150       | 195       |
| M.-L. „ „                                    | 483       |       | 31        | 500       |
| 70-pounder, ammunition granted by Committee. |           |       |           |           |
| 12-pounder                                   | do.       |       | do.       | do.       |

SIR, Shoeburyness, September 13, 1864.

THE Committee have addressed a letter to the Secretary of State for War informing him of the amount of ammunition still undelivered, and requesting his sanction to decline to receive any ammunition which is not delivered at Woolwich by noon on October 1st next. I am directed to give you this information that you may make arrangements for supplying what is still deficient, a list of which is annexed.

I am further directed to inform you that this applies also to the ammunition you propose to deliver for your 12- and 70-pounder programmes.

I am, &c.

(Signed) H. DYER, Captain, R.A., and Major,  
J. Whitworth, Esq., Manchester. Secretary.



Still due:—

|                              |              |        |
|------------------------------|--------------|--------|
|                              | 70-pounders. |        |
| Shot                         | -            | - nil. |
| Common shell                 | -            | - 230  |
| Shrapnel shell               | -            | - 260  |
| Common case                  | -            | - 30   |
| Special shell (steel)        | -            | - 8    |
|                              | 12-pounders. |        |
| Common case                  | -            | - 30   |
| 70-pr. programme ammunition. |              |        |
| 12-pr.                       | "            | "      |

SIR, Shoeburyness, September 15, 1864.

I AM directed by the Committee to call your attention to the practice made with your 70-pr. gun on Tuesday last the 13th instant, by which it appears that the shell had far less range and the gun less recoil when fired from the rear vent than when fired from the top vent, thus indicating that a less strain is brought on the gun by like charges when fired from the rear vent. As the experiments, therefore, are very unequal as regards endurance, the Committee desire me to request that you will at once select from which of the vents all the future experiments with your 70-pr. gun are to be conducted, as they have decided that only one of the vents can be made use of.

I have also to inform you that the Committee have further decided that no practice is to be carried on with the 70-prs. until your decision on this question has been communicated to them.

I have, &c.

(Signed) H. DYER, Captain R.A., and Major,  
J. Whitworth, Esq., Secretary.  
Manchester Ordnance Company, Manchester.

SIR, Shoeburyness, September 19, 1864.

IN reply to your letter of the 17th instant, the Committee direct me to inform you that they have made arrangements to fire 20 rounds shot at 5° and 20 rounds at 8° on Thursday morning at 9, at Shoeburyness, to enable you to determine which vent you will adhere to for the remainder of the experiments. Immediately you decide on the vent to be used hereafter, the Committee will be prepared to fire the steel shell.

I have, &c.

(Signed) H. DYER, Captain R.A., and Major,  
J. Whitworth, Esq., Secretary.  
Manchester.

SIR, Shoeburyness, September 19, 1864.

IN reply to your letter dated September 17, 1864, informing the Committee that some of your 70-pounder common shell were not yet delivered, and proposing to supply a different description, I am directed by the Committee to inform you that they must be in possession of a pattern of the shell you propose before they can take the question into consideration.

I have, &c.

(Signed) H. DYER, Captain R.A., and Major,  
J. Whitworth, Esq., Secretary.  
Manchester.

SIR, Shoeburyness, September 22, 1864.

THE Committee have learnt with surprise that an alteration has been made in the shrapnel shell for the 70-pounder gun. As this change has been made without any intimation having been given to them they request you will be good enough to afford them some explanation.

I am, &c.

(Signed) H. DYER, Capt. R.A., and Major,  
J. Whitworth, Esq., Secretary.  
Manchester Ordnance Company, Manchester.

SIR, Shoeburyness, October 10, 1864.

IN reply to your letter dated September 28, 1864, requesting to be allowed to supply a second description of common shell for your 70-pounder guns, I am directed by the Committee to inform you that the Secretary of State for War having deemed it expedient by letter dated 19/9/64, to fix October 1, 1864, as the latest date up to which ammunition intended for the competitive experiments might be received, and having decided that the experiments should be brought to a close with the ammunition then at the disposal of the Committee, they regret that it is not in their power to deviate from these instructions.

I am, &c.

(Signed) H. DYER, Captain R.A., and Major,  
Sir W. G. Armstrong, C.B., Secretary.  
Newcastle-on-Tyne.

109, Victoria Street, Westminster, S.W.,

September 27, 1864.

SIR,

It having been brought to the notice of the Committee that the competitive guns have been repaired without their knowledge, I am directed to inform you that in future no repair will be permitted until its nature be clearly stated in a written memorandum to the Committee, which, when approved, will be forwarded to the Brigade-Major at Shoeburyness to give the necessary orders.

I have, &c.

(Signed) H. DYER, Capt. R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.  
Newcastle-on-Tyne.

109, Victoria Street, Westminster, S.W.,

September 27, 1864.

SIR,

It having been brought to the notice of the Committee that the competitive guns have been repaired without their knowledge, I am directed to inform you that in future no repair will be permitted until its nature be clearly stated in a written memorandum to the Committee, which, when approved, will be forwarded to the Brigade Major at Shoeburyness to give the necessary orders.

I have, &c.

(Signed) H. DYER, Captain R.A., and Major,  
J. Whitworth, Esq., Manchester. Secretary.

SIR, Shoeburyness, September 22, 1864.

WITH reference to the request contained in your letter of the 26th, to replace your supply of 70-pounder common shell, I am directed by the Committee to inform you that they approve of your doing so on the distinct understanding that no expense whatever is entailed on the Government by the change.

I am, &c.

(Signed) H. DYER, Captain R. A., and Major,  
J. Whitworth, Esq., Manchester. Secretary.

SIR,

Bexhill, October 17, 1864.

IN reply to your letter relative to testing the destructive effect of 70-pounder common shell, I am directed to inform you that you are mistaken in supposing that two different descriptions of common shell are to be used with Mr. Whitworth's 70-pounder gun. The same common shell that is fired for range and accuracy will be fired also for destructive effect.

I have, &c.

(Signed) H. DYER, Captain R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.  
Newcastle-on-Tyne.

SIR, Shoeburyness, October 28, 1864.

I AM directed by the Armstrong and Whitworth Committee to acknowledge the receipt of your letter of the 19th, and to observe, that in their original programme made in February 1863, the Committee determined to test the destructive effect of the competitive projectiles "as common case;" but that application was made by you on the 18th January 1864 to supply 10 rounds of case shot for your guns, to which request the Committee acceded.

Some case shot similar in principle were subsequently supplied by the Royal Laboratory for Mr. Whitworth's gun. When the day was fixed for firing with case shot the Committee learned that those supplied by you were of a pattern which had been proposed after experiment at Shoeburyness, by Lieut. Reeves, R.A., for your guns.

Mr. Whitworth then objected to firing these case shot, on the ground that no experiments similar to those made by Lieutenant Reeves with your guns had been carried on to test their applicability to his system of rifling, and proposed to the Committee to prepare some case shot for experiment adapted to his system; to which proposition the Committee also acceded; and as you were in daily attendance at Shoeburyness in May last when these proceedings took place, the Committee consider that you must have been fully aware of this decision.

I am to add, that every latitude having been afforded to the competitors, by placing at their disposal 200 or more additional rounds to enable them to produce such projectiles as they might deem best calculated to develop the merits of their respective guns, the Committee consider that you could have brought forward pattern of case shot which in your opinion might have been best adapted for that purpose, in the same manner as you have done with other projectiles of a different pattern from those supplied by you previous to the 1st April 1864, and which have only been delivered to the Committee so late as the 30th September last.

I am further directed to state that as both you and Mr. Whitworth have from the first been represented by your respective nominees on the Committee, the Committee consider that you are both kept fully informed of such of their proceedings or decisions as may affect your respective interests, and that the Committee have always given their most attentive and careful consideration to any representations made to them connected therewith. The Committee therefore regret that you had not expressed a wish, after the experiments with case shot had been postponed in May last for the afore-mentioned reasons, to produce an improved pattern instead of deferring all mention of the subject until after the experiments had been made with Lieut. Reeve's case shot from your guns and with Mr. Whitworth's from his gun.

I have, &c.  
(Signed) H. DYER, Capt. R.A., and Major,  
Sir W. Armstrong, C.B. Secretary.

MY LORD, Shoeburyness, November 9, 1864.

As the Armstrong and Whitworth Committee have been unable to comply with the instructions of your Lordship, communicated to them in the letter of the Director of Ordnance, marked immediate, No: 80, G.M. No. 659, of the 27th February last, to carry on the competitive trial from day to day until it is finished, I am requested by them to submit the following statement in explanation of the delay which has already occurred, and the further delays which they anticipate in the future.

The Committee is the more desirous that your Lordship should be fully informed of these circumstances, as your Lordship on a previous occasion expressed regret that a necessary adjournment had taken place pending the supply of ammunition.

The Committee is now carrying on experiments at Portsmouth, and being anxious of expediting their operations had determined to continue their practice for range and accuracy simultaneously at Shoeburyness during the current week while the tides are suitable. They received, however, a letter from the Commandant at Shoeburyness dated October 31, informing them that on the 7th and 8th inst. the Ordnance Select Committee were to carry on experiments which the War Office are very anxious to have completed, and that the seven-gun battery on which the Committee's guns are mounted would not be available. The Committee accordingly were unable to carry on any practice on the 7th, and only partially on the 8th.

The Committee also received a letter from the Director of Ordnance, dated October 25, 57/Woolwich/5605, request-

ing them to state whether some arrangement could not be made by the Committee to demand such ammunition as they may require from day to day; to which the Committee, not understanding how they could possibly carry on the experiments at Shoeburyness without more ammunition than would suffice for one day's consumption, suggested on the 26th October that a barge should be sent to Shoeburyness to remain there and serve as a magazine until their experiments are completed. The Committee has received no reply to this communication, but on the arrival of 1,400 rounds of ammunition on the 4th inst. from Woolwich, it had to be returned in consequence of the magazines at Shoeburyness being full of ammunition for other experiments than those required by the Committee. They are therefore left with only 170 rounds per gun available for continuing their practice, and are seriously embarrassed in their proceedings.

The Committee have only further to observe, for your Lordship's information, that the loss of a few days when the tide suits for their experiments, entails a much longer delay than the mere actual loss of time.

I have, &c.  
(Signed) R. RUMLEY, Major-General,  
President.

The Right Hon. Earl de Grey and Ripon,  
Secretary of State for War,  
War Office.

SIR, Shoeburyness, December 20, 1864.

I AM directed to inform you, that unless the request contained in my letter of the 6th inst. is complied with on or before noon on January 1, 1865, the Committee will take upon themselves to strike out 10 per cent. of the rounds fired for range.

I am, &c.  
(Signed) H. DYER, Capt. R.A., and Major,  
Sir W. Armstrong, C.B., Secretary.  
Newcastle-on-Tyne.

SIR, Shoeburyness, December 20, 1864.

I AM directed to inform you, that unless the request contained in my letter of the 6th inst. is complied with on or before noon on January 1, 1865, the Committee will take upon themselves to strike out 10 per cent. of the rounds fired for range.

I am, &c.  
(Signed) H. DYER, Capt. R.A., and Major,  
J. Whitworth, Esq., Secretary.  
Manchester Ordnance Company, Manchester.



## ORDNANCE SELECT COMMITTEE.

Committee Minute, No. 14,413.  
Report, No. 3653.

6th March 1865.

## PRESENT:

Brigadier-General LEFROY, R.A.  
Captain L. G. HEATH, C.B., R.N.  
Colonel HOGGE, C.B., R.A.  
Colonel YOUNGHUSBAND, R.A.  
Lieut.-Colonel GALLWEY, R.E.  
Captain HEYMAN, R.A., Secretary.

SUBJECT:—ARMSTRONG GUNS AT SIMONOSAKI,  
5TH, 6TH, AND 7TH SEPTEMBER 1864.

## COMMITTEE'S REPORT.

*With reference to W.O. Minute, 29/12/64, on 73/3/6072.*

The action at the Straits of Simonosaki has followed that of Kagosima in little more than twelve months, and four of the ships engaged in the second operation were concerned in the first. No substantial change having taken place in the ships' armaments, the accidents and defects reported bear, as would be expected, much the same character.

No case is reported of a vent piece having been blown out on this occasion, although a serious escape of gas took place in one instance, a proof, perhaps, of improved training and greater experience. The material, however, was still of an early date and not calculated to do justice to the powers of the guns with all the improvements of detail that have been applied within the last two or three years. The accidents reported may be reduced to three classes:—

1st. Fracture of vent-pieces—

One 7-inch wrought iron (Taylor's) vent-piece split at the "Euryalus," 12th round on board the "Euryalus." It had previously fired 14 rounds at Kagosima.

Two 7-inch vent-pieces split slightly on board the "Barossa." "Barossa" during 65 rounds: material not stated.

Three 7-inch vent pieces (Taylor's wrought iron) on "Leopard" board the "Leopard" cracked as follows:—

Two in gun No. 273 during the firing of 35 rounds, and one in gun No. 363 during the firing of 51 rounds.

Three 7-inch vent pieces (material not stated) cracked on "Argus" board the "Argus," respectively at the first, the second, and the third rounds, and, having no more vent pieces, the gun was then disabled.

The captain of the "Argus" is less specific as to the number of the gun, the nature of the vent pieces, and other details than the other officers. It might be as well to publish a circular pointing out that accidents as occurred in such rapid succession on board this ship may frequently be avoided by changing the breech-screw, if there is a spare one at hand, or by removing it, and dressing the face to a true bearing with a file and straight edge. It is the breech-screw and not the vent pieces on which suspicion should fall in such cases. A straight edge is now issued for this purpose.

The gun in which these three vent pieces were broken should be carefully examined by an engineer, and the face of the breech screw adjusted.

Two 7-inch vent pieces of wrought iron, probably Taylor's "Coquette." R.G.F. make, on board the "Coquette," cracked respectively at the 40th and 60th round.

Two 40-pr. vent pieces (Taylor's wrought iron) on board "Barrosa." the "Barrosa" cracked, but it is not stated how many rounds they stood respectively. The guns in which they were used both fired 30 rounds.

"Leopard." One 40-pr. gun, E.O.C. was temporarily disabled at the 10th round, owing to an escape of gas which lifted the deck from the beams for several feet immediately above the vent. The vent piece could not be extracted, and the gun had to be changed during the action for its opposite gun. There can be no doubt that this accident was in consequence of careless screwing up.

One 12-pr. vent-piece (Taylor's wrought iron) cracked "Barrosa." on board the "Barrosa." The gun fired 36 rounds.

(2.) *Blowing out of vent-pieces.*

The only instance recorded, which can be considered as approaching the blowing out a vent piece, is the accident which occurred on board the "Leopard" and was clearly the result of negligence in screwing up. It is, however, an evil incidental to this system of breech-loading, and peculiarly liable to occur in the hurry of naval action.

(3.) *Jamming of 7-inch Vent Pieces.*

This is complained of on board the "Euryalus," "Tartar," and "Argus." It is sometimes caused by a little unevenness which an artificer can remove at once, sometimes by hard fouling easily washed away, sometimes by the expansion of the nose of the vent piece where it enters the bush from heat. An iron lever was introduced in May 1863 for the purpose of freeing the vent piece when jammed, but in all probability these vessels were not provided with this lever, and so the "Argus," like the "Racehorse" before Kagosima, suffered the serious inconvenience of having its fire from the gun arrested.

The Committee, however, are much surprised at the duration of this interruption, which is stated to have been 45 minutes, a time they would have supposed much more than sufficient to free the most obstinate jam.

*Efficiency of Pillar Fuzes.*

The "Tartar," "Leopard," and "Argus" complain of the uncertainty of the pillar fuzes, while on the other hand the "Coquette," "Perseus," and "Euryalus" remark that they were very effective, and the latter vessel in particular reports that "too much cannot be said in favour of the 7-inch common shell, which with its large bursting charge is a most terrible weapon. The pillar fuzes with which ours were fired seemed to burst very well indeed, in fact, none that we observed missed."

These contradictory statements are a repetition of what is stated to have occurred on board H.M.S. "Euryalus" and "Argus" in the action before Kagosima in August 1863, and the Committee are unable to suggest any fresh explanation. The pillar fuzes issued to these ships must have been from different supplies, and it is possible that the "Tartar" and "Leopard," as well as the "Argus," have some of the 2,358 unserviceable fuzes which have never been traced.\*

*Efficiency of Time Fuzes.*

The irregularity of burning of the time fuzes is complained of by the "Tartar," while on the other hand the "Perseus" remarks that although the shells burst short at ranges of 2,500 yards and upwards, within those ranges the fuzes acted admirably.

The fuzes are stated to be of white metal with the scale marked in degrees, reading from 0° to 5° 5' or 6° 10'. They are, therefore, of the obsolete pattern of 1861 or 1862, and it is to be regretted that they have not been recalled and replaced by fuzes of later pattern. The circumstance that the shells burst short when fired at ranges of 2,500 yards is what would naturally happen. The time of burning is only equivalent to a range of 1,700 yards or thereabouts. The Committee think the attention of the officer in command should be called to this circumstance. The Committee find nothing further for remark.

The fracture of vent pieces will, it is hoped, become of rarer occurrence when the charge is reduced to 11 lbs., a reduction recommended by them in Report No. 3085,† 23/11/63, and now authorized 73/3/6115, 21/1/65. The reduction of the shot and common shells to 90 lbs. weight, which is also authorized, but will require time to carry out, will still further reduce the strain, and it may be anticipated that even the Taylor's iron vent pieces will then last their proper time. It is not the fact of their cracking which constitutes the evil. Every gun is provided with three of them, and the natural cause of their becoming unserviceable is by cracking. The just cause of complaint is that this occurs so frequently before the vent piece has stood even 50 rounds, arguing material or workmanship of a quality very far below the standard which was supposed to have been attained. The expense of replacing every 7-inch vent piece of Taylor's iron with the best material now known

\* Min. 6039.

† Min. 10,407.

‡ Min. 14,343.

would probably not exceed 27,000*l.*; and although this is a large sum, it must be remembered that as there is scarcely any other serious complaint of the gun, such would be the whole price of restoring much of its prestige as to safety and serviceability.

On the whole the Committee think that the preponderance of testimony is favourable to efficiency of the Armstrong guns, projectiles, and fuzes on this occasion, notwithstanding that many of the stores are of obsolete patterns and of known inferior quality. The report of the gunner of H.M.S. "Perseus," forwarded by Captain Kingston with his approval, is particularly deserving notice, as showing that these guns have warm advocates as well as opponents among the officers of the fleet. It refers, however, to 40-prs. only and not to the 7-inch guns.

The frequent changes of detail in respect to Armstrong materiel within the last four years have pointed to the expediency of calling for a general inspection for the purpose of rectifying the confusion which no doubt exists, and of effecting the necessary replacements. Instructions are in course of preparation for the guidance of those officers who will be entrusted with the inquiry, and it is to be hoped that the steps about to be taken will lead to the immediate withdrawal of the vent pieces of early patterns, the unserviceable fuzes, and the obsolete stores of other kinds, whose continuance in the service brings discredit on the whole and shakes the confidence of the services in their materiel.

(Signed) J. H. LEFROY,  
Brigadier-General, R.A.  
President.

True copy,  
H. Heyman,  
Assistant Secretary.

#### ORDNANCE SELECT COMMITTEE.

Committee Minute, No. 10,815, 15/1/64.  
Report, No. 3,160. 29th January 1864.

##### PRESENT:

Brigadier-General LEFROY, R.A.  
Captain L. G. HEATH, C.B., R.N.  
Colonel HOGGE, C.B., R.A.  
Colonel YOUNGHUSBAND, R.A.  
Lieut.-Colonel R. S. BAYNES, Unatt.  
Lieut.-Colonel GALLWEY, R.E.  
Captain HEYMAN, R.A., Secretary.

SUBJECT:—ARMSTRONG GUNS AT KAGOSIMA, JAPAN,  
August 1863.

#### COMMITTEE'S REPORT.

With reference to W.O. letter, dated 11/12/63, 73/3/4709.

In returning the accompanying reports of the behaviour of the Armstrong guns on board Vice-Admiral Kuper's vessels in the engagements with the Japanese Forts at Kagosima on the 15th and 16th August 1863, the Committee have to point out that the defects which are commented upon by some of the commanding officers are for the most part familiar, and have been the subject of previous reports.

They may be reduced to three classes.

(1.) *Excessive recoil of the 110-pr. gun, endangering the carriage.*

This proves nothing more than that the gun is over charged for its weight. It may be met in two ways, (a) by reducing the charge, (b) by reducing the weight of the shot and shells, retaining the present charge, (b) by reducing the weight of the shot and shells, retaining the present charge, and so realizing a higher velocity. The 7-inch calibre is properly a 42-pr., and the Armstrong gun is actually somewhat lighter than the 42-pr. of 84 cwt., which had the former charge of 14 lbs., and but little heavier than the other 42-prs. of 75 cwt., which had the present charge of 12 lbs. Had that gun been fired double or triple shotted, with a full charge, no one would have been surprised by an excessive recoil, and the mechanical effects are the same, although the increased strength of the gun makes it safe to fire an elongated shot equal to two or three round shot from it. The Committee are now engaged on experiments to determine the best way in which to relieve this gun, and Sir Wm. Armstrong is engaged on a plan for more effectually checking recoil. It may therefore be hoped that this evil will be soon removed.

(2.) *Fracture of Vent Pieces.*

3 steel 40-pr. vent pieces cracked on board H.M. Ship *Euryalus*, respectively at the 13th, 15th, and 31st round

of the gun since received on board, it may be inferred at the same round of the vent piece, and 2 steel 40-pr. vent pieces in the same ship had their neck blown off at the 11th and 62nd round respectively, but are not described as having otherwise failed. In one case it is stated that the vent piece was screwed home, in the other that it was not.

These vent pieces were of the original E. O. Company make, of a material now known to be unsuitable, thinner in the proportion of 3·4 to 4·0 inches than the present pattern, and consequently weaker in about the proportion 11·5 to 16·0.

1. Royal Gun Factories 40-pr. vent piece, of Taylor's wrought iron, on board the "*Euryalus*," split at the 34th round.

2. Royal Gun Factories 40-pr. vent pieces, of Taylor's iron, were blown out, and the cross head blown away, on board H.M. Ship "*Perseus*," after 15 and 30 rounds respectively.

There can be no doubt that the last accident was the consequence of carelessness in screwing up, the breech screw being found after the explosion not nearly home. This material however (Taylor's wrought iron) is now known to be deficient in strength, and is no longer employed.

1. Royal Gun Factories 110-pr. vent piece of Taylor's wrought iron in the same vessel, was broken off at the neck at the 38th round.

(3.) *The Blowing out of Vent Pieces.*

This accident occurred twice on board the "*Perseus*," as stated above, but is not reported by any other vessel, and was clearly the result of negligence. It is, however, an evil incidental to this system of breech-loading. It does not appear whether these guns had indicator rings.

(4.) *Jamming of 110-pr. Vent Pieces.*

This is complained of on board the "*Racehorse*," and "*Argus*." It is an accident which occurs sometimes, and since May 1863\* an iron lever has been issued for the express purpose of freeing it. In all probability these vessels were not provided with this lever, and so the "*Racehorse*" suffered the serious inconvenience of having its fire from this gun arrested for about 25 minutes.

(5.) *Deficiency of Low Gauge Tin Cups noticed on board the "Coquette."*

It seems impossible to tell whether a gun will take high gauge or low gauge cups prior to experience with it, and the Committee would recommend that in all cases in which high or low gauge is not distinctly specified, the cups should be issued in duplicate, the full number of each, those which are found unsuitable to be returned to store at the first opportunity.

(6.) *Premature Explosion of Pillar Fuzes.*

This is complained of by the "*Argus*," which fired 7 common shells, and states that they all exploded 50 or 100 yards from the gun; on the other hand the "*Euryalus*" remarks that the action of the pillar fuzes was admirable. "Too much cannot be said in favour of the common shell fitted with pillar fuzes, which are certainly the most destructive projectiles now in use, not one appeared to miss or burst."

These contradictory statements leave no room to doubt that the fuzes were of different supplies. Possibly the "*Argus*" may have been furnished with some of the 2,358† pillar fuzes of an early delivery, which are known to be unfit for service, but have unfortunately been lost sight of and probably been issued in error. It is not likely that she had those of Royal Laboratory make referred to in the Report on the Newhaven Experiments.

The Committee have already suggested a further inquiry, which has been ordered. The Committee have nothing further to remark.

They enclose for the perusal of the Secretary of State, Sir Wm. Armstrong's letter on this subject, and in reference to the old pattern untempered steel vent pieces of 40 and 110-pr. guns, they think that wherever they exist they should be returned to store, and the latest pattern vent pieces be issued instead. If for 40-prs. of the original pattern it must be expressly so stated, as that gun will not, until altered, take the same vent piece as the G pattern gun, but there is a pattern for it, stronger than the original one. With respect to the Taylor iron 110-pr. vent pieces, which are much superior to the untempered steel ones, but inferior to those of Swedish iron, and of tempered steel, the Committee think it will become necessary that they should also be recalled as soon as possible, unless the contemplated reduc-

\* Cir. 835, § 769.

† Min. 6,089.



tion of charge or weight of shot for that gun should relieve them sufficiently to permit their use to be continued.

With respect to the 40-pr. vent pieces of Taylor's iron, they do not think there are at present sufficient grounds for recommending either the recall of these vent pieces or a reduction in the charge of the gun.

(Signed) J. H. LEFROY,

True copy,  
H. Heyman,  
Assistant Secretary.

Brigadier-General, R.A.,  
President.

SIR,

I HAVE the honour to forward herewith for the information of the Lords Commissioners of the Admiralty reports called for by me from the "Euryalus," "Coquette," "Perseus," "Argus," and "Racehorse," containing all particulars respecting the Armstrong guns used in the recent action at Kagosima, the number of rounds fired, a statement of accidents, &c., with the opinion of the several officers in command of those vessels as to the general efficiency of the guns, which may be interesting.

I have, &c.

(Signed) AUGUSTUS L. KUPER,  
Vice-Admiral and Commander-in-Chief.

The Secretary of the Admiralty.

REMARKS ON THE PRACTICE made with the ARMSTRONG GUNS, of H.M.S. "EURYALUS" at KAGOSIMA, and the results of the firing on the guns.

The 110-pr. pivot gun was fired rapidly and with high elevations both on the 15th and 16th of August. The concussion was very great, especially when (on the 16th) 13 rounds were fired at 4,000 yards with an elevation of 12° and two rounds at extreme elevation. The rear chock of the carriage was broken off from the shears where train whip is rove, and the sides of the carriage were much shaken and cracked. The slide showed symptoms of giving way, but, as the screws in the rear post came out, it only bent slightly.

The vent piece which had the neck blown off on the 15th was properly screwed up, for when examined immediately afterwards, the post that remained was firmly fixed in its place and was only removed after some difficulty. There was nothing to show the cause of the accident, and the only way to account for it is by supposing that a flaw existed. As shown by the list of casualties it was made of

iron. The carriage is an old one (having been originally fitted for a 68-pr.) and would probably have suffered nearly as much had a smooth-bored gun been fired from it with the same elevations. The carriages and rear chocks should, however, be made much stronger, as when used with 68-prs. they were never submitted to so continued a strain, for the gun having three charges, the heaviest was only fired on rare occasions, whereas with Armstrong the charge is always the same. The practice made from this gun at long ranges was very good. Too much cannot be said in favour of the common shell fitted with a pillar fuze, which are certainly the most destructive projectiles now in use; not one appeared to miss bursting and they were very closely watched. The explosion could be heard distinctly at 4,000 yards.

For all purposes the pillar fuzes appear much better than either "Time" or "Moorsom's," the former requiring so much care in adjusting, and the latter not bursting when fired against earthworks.

When the distance varies greatly and it is desirable to keep up a rapid fire, their superiority to all others is very apparent, for merely touching the top of a parapet is sufficient to explode them.

With respect to the 40-pr. guns, the same complaint may be made as with the 100-pr., viz., that the carriages were not strong enough to bear continued firing at high elevations. Two beds were broken by the concussion. Six vent pieces were disabled, of which four had deep cracks right across, one had the neck blown off in the same manner as the 100-pr.; but in this case there can be no doubt the breech screw had not been set up properly; another had the handles and lock blown off from the same cause. In quick firing the vent pieces get heated and expand, and when they cool again the copper rings drop off. This only occurred in two cases, and then to the cracked vent pieces. The damage done to the grooves of the guns was in all cases slight and hardly noticeable. The broadside 110-prs. were not fired often, and consequently no accidents happened to them. They appear to be the only ones that have carriages strong enough to stand the concussion of continued firing at high elevations. As shell guns they are very valuable on the main deck, but the ports will not allow sufficient elevation to be given them, so that they may be used at the same distances as upper deck guns.

(Signed) RICHARD TRACEY,  
Gunnery Lieut.

Approved.  
(Signed) T. H. ALEXANDER,  
Captain.

H.M.S. "Euryalus," Yokohama, 10th September 1863.

REPORT OF ARMSTRONG GUNS AND CARRIAGES.

| Nature of Gun. | Register. | Factory Mark. | Date when made. | No. of Rounds fired.* | Blank. | Remarks.                                                                                                    | Fired at Kagosima. |
|----------------|-----------|---------------|-----------------|-----------------------|--------|-------------------------------------------------------------------------------------------------------------|--------------------|
| 110-pr.        | 96        | R. G. F.      | 1861            | 38                    | 8      | Vent-piece broken off at neck; rear chock of carriage broken; carriage much shaken and cracked.             | 26                 |
| "              | 390       | "             | "               | 13                    | 29     | - - - - -                                                                                                   | 10                 |
| "              | 410       | "             | "               | 12                    | 24     | - - - - -                                                                                                   | 9                  |
| "              | 39        | "             | "               | 24                    | 29     | - - - - -                                                                                                   | 6                  |
| "              | 271       | "             | "               | 25                    | 21     | - - - - -                                                                                                   | 7                  |
| 40-pr.         | 7         | E. O. C.      | 1860            | 29                    | 10     | - - - - -                                                                                                   | 9                  |
| "              | 9         | "             | "               | 13                    | 13     | Vent-piece split; about two inches broken off one of lands about a foot from seat of shot, lower part.      | 12                 |
| "              | 40        | "             | "               | 15                    | 12     | Vent-piece split - - - - -                                                                                  | 13                 |
| "              | 45        | "             | "               | 11                    | 12     | Handles blown off vent-piece and hammer blown away -                                                        | 9                  |
| "              | 52        | "             | "               | 31                    | 9      | About an inch broken off two lands a foot from seat of shot; vent-piece split; bed and carriage broken.     | 11                 |
| "              | 80        | "             | "               | 33                    | 8      | - - - - -                                                                                                   | 13                 |
| "              | 164       | R. G. F.      | "               | 34                    | 7      | Small piece broken off; five lands (joining each other) about 9 inches from seat of shot; vent-piece split. | 10                 |
| "              | 211       | E. O. C.      | "               | 62                    | 5      | Neck of vent-piece blown away; hammer blown off.                                                            | —                  |

\* This column gives the whole number of rounds that have been fired since the guns have been on board; not including blank vent-pieces.

## VENT-PIECES.

|             |   |   |   |       |   |   |          | No.  |                  |
|-------------|---|---|---|-------|---|---|----------|------|------------------|
| 110-pounder | - | - | - | Iron  | - | - | R. G. F. | -    | Neck broken off. |
| 40-pounder  | - | - | - | "     | - | - | "        | 164a | Cracked.         |
| "           | " | - | - | Steel | - | - | E. O. C. | 45b  | "                |
| "           | " | - | - | "     | - | - | "        | 80a  | "                |
| "           | " | - | - | "     | - | - | "        | 211b | "                |
| "           | " | - | - | "     | - | - | "        | 80b  | "                |
| "           | " | - | - | "     | - | - | "        | 45a  | Neck broken off. |

H.M.S. "Coquette," at Yokohama, 1st September 1863.

## REPORT ON ARMSTRONG GUN.

| Description of Gun.                                      | Marks on Gun.        | Total No. of Rounds fired.        | No. of Rounds fired at Kagosima. | Remarks.                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------------------------------------------|----------------------|-----------------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Armstrong 110-pr.<br>Length, 10 feet.<br>Weight, 82 cwt. | R. G. F.<br>No. 177. | Shot and Shell, 85 ;<br>Blank, 2. | Shot and Shell, 37.              | The high gauge tin cups do not fit, thereby causing unnecessary delay after every round, in having to wedge the vent-piece out. The high gauge tin cups never fitted, and all the low gauge cups are expended. The gun worked in every other way very satisfactorily. The starboard breeching bolt in ship's side broke, not being stout enough ; another one also drew, woodwork being defective. |

Approved.  
(Signed) J. H. ALEXANDER,  
Commander.

(Signed) ALBERT E. KAY,  
Lieutenant.

H.M.S. "Perseus," at Yokohama, 7th September 1863.

## RETURN OF ARMSTRONG GUNS on board this Ship.

| Register No. | Description.           |                           |             | No. of Rounds fired.     |                          |                 | Accidents.                                                       |                           |                   |                | Remarks.                                                                                                                                                                                                                                                                                                          |
|--------------|------------------------|---------------------------|-------------|--------------------------|--------------------------|-----------------|------------------------------------------------------------------|---------------------------|-------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | Size and Marks.        | Weight.                   | Length.     | On 15th and 16th August. | Previous to 15th August. | With Shot.      | Part of Gun, and Marks.                                          | Description.              | Charge of Powder. | Projectiles.   |                                                                                                                                                                                                                                                                                                                   |
| 201          | 40<br>E. O. C.<br>1860 | cwt. qrs. lbs.<br>33 3 14 | Feet.<br>10 | 37                       | Blank.<br>8              | With Shot.<br>2 | Vent-piece,<br>40-pounder,<br>Taylor's iron,<br>R.G.F., No. 55.  | Upper part<br>blown away. | lbs.<br>5         | Solid<br>shot. | This vent-piece was blown up after firing about 30 rounds. After the explosion the breech-screw was back about two threads, although the captain of the gun says it was screwed up previous to firing.                                                                                                            |
| 30           | 40<br>E. O. C.<br>1860 | 31 0 0                    | 10          | 15                       | 18                       | 1               | Vent-piece,<br>40-pounder,<br>Taylor's iron,<br>R.G.F., No. 133. | Shoulder<br>blown away.   | 5                 | Shell.         | This vent-piece was blown up after 15 rounds. After the explosion the breech-screw was back about one thread.                                                                                                                                                                                                     |
| C3           | 40<br>E. O. C.<br>1861 | 32 2 0                    | 10          | 23                       | 12                       | 1               | —                                                                | —                         | —                 | —              | From the incessant rain it was impossible to keep chalk marks on the breech and screw to show No. 1 when the breech was up, and my opinion is that in consequence of there being no marks and the end of the screw being foul from repeated firing, it was not sufficiently up, which accounts for the accidents. |
| 54           | 40<br>E. O. C.<br>1861 | 32 1 9                    | 10          | 15                       | 11                       | 2               | —                                                                | —                         | —                 | —              | The cartridges in two or three instances were found to be too large in diameter to admit of their going in easily, and in consequence some delay was occasioned in loading, and several of the cartridges burst in forcing them in.                                                                               |
| 222          | 40<br>E. O. C.<br>1861 | 33 3 12                   | 10          | 20                       | 15                       | 1               | —                                                                | —                         | —                 | —              | In every other respect the guns answered remarkably well.                                                                                                                                                                                                                                                         |

(Signed) AUGUSTUS J. KINGSTON,  
Commander.



H.M.S. "Argus," at Yokohama, the 3rd September 1863.

A LIST of ARMSTRONG GUNS and the Number of Rounds fired from each on board whilst at Kagosima.

| Nature of Gun. | Registered No.          | Where and when received. | Charge. | Shot. | Segment Shell. | Common Shell. | No. fired. | Remarks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------|-------------------------|--------------------------|---------|-------|----------------|---------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 110-pr.        | R. G. F. No. 559. 1861. | Chatham, in August 1862. | lbs. 12 | 2     | 13             | 7             | 22*        | The rifling of the 110-pr. is slightly broken, but of no serious consequence. The gun requires new re-facing. The common shells that were fired with pillar fuzes from the 110-pr. all exploded between 50 and 100 yards, and we have every reason to believe that a shell burst in the gun, which damaged the rifling as mentioned. The segment shell and shot were very accurate.<br>Our opinion as to the efficiency of the 110-pr. Armstrong gun is, that the vent-piece continually jamming, and its great weight, is a serious drawback to quick firing, and is not a good gun for short ranges. This does not apply to the 12-pr., which may be fired very quickly and with precision. |
| 12-pr.         | R. G. F. No. 17. 1861.  |                          | 2½      | 0     | 12             | —             | 12         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 12-pr.         | R. G. F. No. 41. 1861.  |                          | 2½      | 0     | 8              | —             | 8          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

\* The repairs of this gun are being effected by Mr. Fisher, Assistant Engineer of H.M. gunboat "Kestrel."  
Approved.  
LEWIS J. MOORE, Commander.

H.M.S. "Racehorse," Yokohama, September 7, 1863.

REPORT on the ARMSTRONG GUNS on board H.M.S. "RACEHORSE."

| Gun.                                                      | Marks.                                                                               | Number of Rounds Fired. |        | Number of Rounds fired at Kagosima.        | Remarks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------|--------------------------------------------------------------------------------------|-------------------------|--------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           |                                                                                      | Shot and Shell.         | Blank. |                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 6-pr. Armstrong. 8 cwt. 0 qr. 10 lbs. Length, 5 feet.     | R. G. F. No. 39. Made 1860. Projectiles marked R. L.                                 | None                    | None   | 2 shot, 15 shell (segment).                | The trail of carriage broken on the 17th round.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 110-pr. Armstrong. 81 cwt. 1 qr. 10 lbs. Length, 10 feet. | On trunnion R.G.F. No. 165. Date 1861. Doubled bushed iron. Projectiles marked R. L. | Shot, 2; Shell, 4.      | 2      | Shot 24, segment shell 23, common shell 4. | During the first day of the engagement at Kagosima great difficulty was found in getting the 110-pounder to go off, from the quantity of rain falling, which so thoroughly wetted the vent piece, and ran into the interior of the chamber, that it was found necessary to unload the gun three times to replace the cartridges which had got wet.<br>Besides this, the gun missed fire eight or nine times. This occasioned great delay at a time when it was of great importance to get the gun fired as soon as possible. On trying to remove it with |

ance we should keep up a rapid fire. After the 15th round the vent piece got jammed so hard in the breech that on trying to remove it with levers and handspikes one of the handles came off.  
From this accident the firing of the gun was delayed for at least 25 minutes. During the whole of this time the smooth-bore guns which were being fired under the same adverse circumstances kept up a continuous and rapid fire.  
On the second day the vent piece jammed twice, and on one of the occasions it caused a delay of 10 minutes in the firing of the gun.  
From the experience I have had of this gun during the operations at Kagosima, I am of opinion that, for general service, it is not so efficient as the 68-pounder 95-cwt. gun, and that it would be improving the armament of this ship were one of the latter supplied in lieu of it.

(Signed) C. B. BOXER, Commander.

SIR, Admiralty, 23rd December 1864.

I AM commanded by my Lords Commissioners of the Admiralty to send you herewith, for the information of the Secretary of State for War, a copy of a letter from the Commander-in-Chief on the China Station, dated the 7th October last, with eight enclosures, forwarding reports on the Armstrong guns engaged in the recent operations in the Straits of Simono Seki, Japan.

I am, &amp;c.

The Under Secretary  
of State for War.

W. G. ROMAINE.

"Euryalus,"  
"Tartar,"  
"Conqueror,"  
"Barrosa,"  
"Leopard,"  
"Argus,"  
"Persens,"  
"Coquette."

reports, from the ships named in the margin, on the performance of the Armstrong guns engaged in the recent operations in the Straits of Simono Seki.

2. My late experience of the working of these guns has served to confirm me in my opinion that the vent pieces, as at present fitted, and particularly in the 110-pounder gun, are too easily put out of order to render the guns perfectly efficient as a naval weapon.

I have, &amp;c.

(Signed) AUGUSTUS L. KUPER,  
The Secretary of the Admiralty, Vice-Admiral and  
&c. &c. Commander-in-Chief.

REPORTS ON ARMSTRONG GUNS engaged at SIMONO SEKI.

(Copy.)

"Euryalus," at Yokohama,  
7th October 1864.

SIR, I HAVE the honour to forward herewith, for the information of the Lords Commissioners of the Admiralty,

REPORT of ARMSTRONG GUNS of H.M.S. "Euryalus," fired during the engagements with the Forts at Simono Seki, on the 6th September 1864.

110-pr. No. 96. From this gun 25 rounds were fired, 22 common shell pillar fuze, and 3 shot. The first 12 rounds were fired with vent piece No. 958, Taylor's wrought iron R. G. F., which then split across the back and was changed for No. 774, Taylor's wrought iron R. G. F., which

F f

was used for firing the remaining rounds without sustaining any injury. The gun being still loaded prevents an examination of the grooves, but up to the last time of loading no damage had been observed. The total number of rounds fired with the broken vent piece, No. 958, was 26, viz., 14 at Kagosima and 12 on this occasion.

|                |                            |            |
|----------------|----------------------------|------------|
| 40-pr., No. 9, | fired 1 shot and shell     | no damage. |
| " " 45         | " 1 shot                   | no damage. |
| " " 40         | " 1 shot                   | no damage. |
| " " 7          | " 1 shot 3 shells (segt.), | no damage. |
| " " 52         | " 1 shot 1 shell (segt.),  | no damage. |
| " " 80         | " 1 shot 2 shells (segt.), | no damage. |
| " " 211        | " 1 shot 3 shells (segt.), | no damage. |
| 20-pr., " 96   | " 1 shot 1 shell (segt.),  | no damage. |

The 40-prs. being still loaded cannot be examined. None of the vent pieces have sustained any injury.

#### REMARKS.

The 110-pr. pivot gun was fired, at distances ranging from 2,500 to 4,500 yards, with deviations from 7 to 13 degrees. For the first five rounds the gun worked easily, but after the fifth the vent piece began to swell considerably, so that some difficulty was found in getting it out after the breech was unscrewed; this difficulty continued to increase until after the 12th round, when the gun was delayed for about five minutes by the impossibility of getting it out until it had cooled a little. The vent piece by which it was replaced showed no signs of swelling during the 13 rounds which were fired with it.

Considerable difficulty was found in forcing home the shell after the first five rounds, as the inner part of the breech screw became buried by the shock of the recoil; sometimes it took 10 men to ram it home; once beyond the breech screw, however, it went up easily enough into the seat of the shot.

When firing at short ranges (up to about seven degrees) the gun can be worked quickly, as no great strain is brought upon any part, and the gun can be re-loaded directly after being run out, without elevation; with more than seven degrees elevation, however, the bed has to be removed, and the elevating screw can no longer be used. The strain upon the coin is so great that it invariably flies out and lets the gun down on the rear chock, so that time is lost in loading, as the gun must be elevated to allow the men who ram home the projectile to bring their whole strength upon the rammer.

None of these disadvantages are felt in the 40-prs., which being so much lighter are easily managed; those belonging to this ship, however, were not used often enough to give us a good opportunity of judging.

There seems to be one defect in all the Armstrong carriages which might easily be remedied; none of them are made high enough in the fore part to give the gun the elevation corresponding to its great range. If the carriages for the 40-pr. quarter deck guns were made much higher and the hammock nettings made to unship, an elevation of 11 or 12 degrees might be given without removing the elevating screw, which would be a great convenience and much facilitate the working of the gun at long ranges.

Too much cannot be said in favour of the 110-pr. common shell, which, from its large bursting charge, is a most terrible weapon. The pillar fuzes with which all ours were fired, seemed to burst very well indeed, in fact none that we observed missed; whether they would do so at shorter ranges when the shock of striking would not be so great we have had no opportunities of judging.

The difficulty caused by the expansion of the vent pieces by heat might be guarded against by keeping three at each gun during action and using them for five rounds alternately; each might then be carefully cleaned and examined before being used again, so that the slightest flaw might be at once detected. If one vent piece be used for a long time it might be seriously cracked without attracting notice. The breech screw, which generally works rather hard after a few rounds have been fired, might be eased considerably by being run out to the end and washed down with a few buckets of water.

(Signed) RICHARD E. TRACEY,  
Gunnery Lieutenant.

Approved,  
W. M. HOWELL,  
Captain.

#### REPORT ON THE ARMSTRONG GUNS.

H.M.S. "Tartar," Inland Sea, Japan,  
21st September 1864.

SIR,

WITH reference to your general memorandum of the 14th instant, relative to the efficiency of the Armstrong guns, I have the honour to state that I consider its accuracy and power make it very valuable as a long range gun; but for any distance not much exceeding 1,500 yards (more particularly for naval action, when a few minutes delay in firing might be fatal) I consider the 95-cwt. smooth bore, on the whole, its equal, though the effect of the spherical shell is certainly very much less.

2. The jamming or splitting of the vent piece I consider the chief objection to this description of gun (110-pr.) on board the "Tartar;" in my opinion this is chiefly attributable to these guns being overcharged (unless when extraordinary range or penetration is required) when the great and possibly useless resistance to the shot is considered.

3. On the 5th September about 50 rounds were fired with the same vent piece, no delay or accident of any sort occurring, the gun and vent piece remaining uninjured. On the 6th the vent piece showed several marks cut by the gas after eight or ten rounds had been fired, the cuts or flaws being about  $\frac{3}{8}$  of an inch deep and  $\frac{1}{4}$  broad. A new vent piece was now used, which jammed slightly the first round, requiring the end of a handspike to remove it; it jammed again after about 10 rounds, giving more trouble and causing a loss of several minutes to clear it, the vent piece apparently uninjured. About the 20th round the vent piece again jammed so firmly that it required 10 minutes to remove it; this was done by a rammer from the muzzle struck by a maul, while a handspike was used in the loops.

4. On the 8th the gun was again used with the same (or second) vent piece, and fired about 28 times at ranges from 4,000 to 2,500 yards; nothing was observed to go wrong till the firing ceased, when the vent piece was found to be split near the centre of bottom, extending two inches, and half an inch deep, apparently a welding or previous flaw in the metal. Both these vent pieces are still serviceable, the first having been refaced. A considerable flaw was also found in the bush ring, as described in the accompanying report. The bush has been replaced, and the gun is now ready for any service, but as a shell still remains in it, it is impossible to examine the bore minutely; this will be done as soon as possible, and a further report sent should there appear anything worthy of remark.

5. The whole of the fuzes supplied for this gun, both time and pillar, proved very uncertain, the former nearly always burning short of the time set for, and not half of the latter exploding on striking, the object struck being dry clay and sand, and in some places gravel; they never exploded on striking the water; one shell with pillar fuze open at the end burst on leaving the gun; those closed at the rear are marked E x 1 A.P.; the open ones are marked T A, and on the open end P.

6. The smoke from these guns (caused by the lubrication I suppose) is in some instances very inconvenient. Both on the 5th and 6th of September, though there was light breeze sufficient to clear the smoke from an ordinary gun in time to see where the shot struck at a range of 1,700 yards, the thick yellowed smoke from the Armstrong gun prevented our doing so. It was impossible to say exactly what shells did or did not explode, as the smoke from the enemy's guns had exactly the same appearance from the ship; very many of Moorsom shells from our 8-inch broadside guns certainly *did not* explode on striking, and I believe the metal time fuzes used with the same guns seldom exploded after burying themselves in the clay or sand.

7. The fuzes of the French shells thrown from their well-shooting rifled guns apparently gave about the same results.

(Signed) JOHN M. HAYES,

Vice-Admiral  
Sir Augustus L. Kuper, K.C.B.,  
Commander-in-Chief.

Captain.



## ARMSTRONG GUNS.

Report from H.M.S. "TARTAR," September 17, 1864.

| Name of Ship. | Nature of Gun, with its No. and Description Marks; also date of issue, and whence.                                                                     | Particulars of Manufacture.               | Details of Flaws, recorded up to Date of last Return.                                                                                                                                                                                                                                                              | Total Rounds fired up to Date of last Return. |       |        | Fired during the recent Operations at Simonosaki. | Details of Flaws developed during current Quarter, annexing No. when they are new ones.                                                                                                                                                                                                                                                                                                                                                              | Vent Pieces, Material, Pattern, and Number of Rounds Fired with each.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                | If Breech Shot, No. of Shots. | Other Accidents, and general Remarks applying to Ammunition, Fuzes, &c.                                                                                                                                                                                                                                                                                                                                                                        |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|-------|--------|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |                                                                                                                                                        |                                           |                                                                                                                                                                                                                                                                                                                    | Blank.                                        | Shot. | Shell. |                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                      | F. against any Refaced this Quarter.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | R. against any which have received a New Ring. |                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| "Tartar"      | 110-pr. No. 169, R.G.F., W.D., Nov. 1862. Gun Wharf, Portsmouth. Received on board "Tartar" July 1863, from H.M.S. "Hacchante," Feb., H.M.S. "Sutlej." | A. Tube coiled. Breech, bush, iron, thin. | Slight flaw in bore at $\frac{1}{4}$ L. of up. 1 L. Flaw $\frac{1}{2}$ L. D. Slight flaw 10 L. of up. 13 $\frac{1}{2}$ L. of up. 29 L. of D. to up. Slight flaw 45 $\frac{1}{2}$ R., 79 $\frac{1}{2}$ L., 59 $\frac{1}{2}$ less. Slight flaw in powder chamber at 5 $\frac{1}{4}$ , 4 d, 6 $\frac{1}{2}$ L. of up. | Nil.                                          | —     | 5      | 84                                                | No alteration appears to have taken place in the flaws previously reported; but as a shell is still in the gun, it is impossible to make full examination. This will be done as soon as the shell can be removed, and a further report made. Bush report damaged, apparently. Welding flaws $\frac{1}{2}$ of an inch from seat of vent piece, extending from bottom 4 inches up left, has been replaced, and the gun to all appearances serviceable. | No. 5. 4 wrought iron. 1 Swedish iron. R. No. 256. Cammelle's Swedish iron. New pattern. Damaged in upper quarter round edge of fitting face left of neck, apparently caused by gas escaping between vent piece and bush ring. Flaws $\frac{1}{2}$ of an inch deep, and $\frac{1}{4}$ of an inch in width. Refaced. Still serviceable. Shifted at the 60th round. Vent piece No. 932, O.P. Taylor's wrought iron welding. Flaw in centre of bottom extending 2 inches round, and probably $\frac{1}{2}$ an inch deep. 30 rounds fired. Flaw not observed till after action. Still serviceable. | None                                           | No                            | Accidents, none. Gun was found to work well. Vent piece No. 932 jammed 3 times; twice easily removed, third time required great force to remove it. Ammunition found to be good. Fuzes: — White metal fuzes were observed to burst before reaching the distance required. Pillar fuzes were not observed to burst regularly. The rapid firing in action, and consequent smoke, renders it impossible to give an accurate account of the fuzes. |

(Signed) J. M. HAYES, Captain.

## Forwarding REPORT ON THE ARMSTRONG GUNS.

H.M.S. "Conqueror," at Simono Seki,  
15th September 1864.

SIR, In compliance with your memorandum of the 14th instant, I have the honour to enclose a return of the Armstrong guns on board Her Majesty's ship under my command. The amount of firing was too small really to test

the efficiency of the guns, but so far as it went the practice was satisfactory, the range accurate, and the shells (pillar fuzes) all burst.

I have, &c.  
(Signed) W. G. LUARD,  
Captain.

Vice-Admiral  
Sir A. L. Kuper, K.C.B.,  
Commander-in-Chief.

H.M.S. "Conqueror," Simono Seki, 14th September 1864.

## REPORT ON ARMSTRONG GUNS.

| Nature of Gun.         | Number and Description. | Number of Times fired. | Efficiency.    | Damage to Gun.                                                                      |
|------------------------|-------------------------|------------------------|----------------|-------------------------------------------------------------------------------------|
| 110-pounder -          | No. 505 R. G. F. -      | 3 times -              | Satisfactory - | Upper bracket bolt slightly started in carriage.                                    |
| " -                    | " 554 " -               | 10 " -                 | " -            | Upper bracket bolt slightly started in carriage; also right rear axle bolt started. |
| 40-pounder -           | " 74 E. O. C. -         | 9 " -                  | " -            |                                                                                     |
| " -                    | " 8 " -                 | 2 " -                  | " -            |                                                                                     |
| " -                    | " 180 " -               | - -                    | " -            |                                                                                     |
| " -                    | " 115 " -               | 1 time -               | " -            |                                                                                     |
| " -                    | " 95 " -                | - -                    | " -            |                                                                                     |
| " -                    | " 128 " -               | - -                    | " -            |                                                                                     |
| " -                    | " 94 " -                | - -                    | " -            |                                                                                     |
| " -                    | " 68 " -                | - -                    | " -            |                                                                                     |
| " -                    | " 67 " -                | - -                    | " -            |                                                                                     |
| " -                    | " 87 " -                | - -                    | " -            |                                                                                     |
| 20-pounder -           | " 119 " -               | 10 times -             | " -            |                                                                                     |
| 12-pounder field piece | " 38 R. G. F. -         | - -                    | " -            |                                                                                     |

Approved.  
W. G. LUARD, Captain.

(Signed) S. GROVE PRICE,  
Gunnery Lieutenant.

## H.M.S. "Barrosa," Simonoseki, 15th September 1864.

## REPORT ON ARMSTRONG GUNS.

| Number. | Description.                | No. of Rounds fired. | Opinion as to Efficiency.           | Particulars of Accident or Damage.                                                                                                                                                                                                                                                                                                                                                                                      |
|---------|-----------------------------|----------------------|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | 110-pr., Register No. 265 - | 65                   | Very accurate.<br>Shell burst well. | Two vent pieces slightly split :—<br>1. No. 484, Taylor's wrought-iron, R. G. F., split in rear part of vent piece, 5½ inches horizontal.<br>2. No. 737, Taylor's wrought-iron, R. G. F., slightly split in rear part of vent piece, 4 inches perpendicular, 1½ inches diagonal.<br>No. 229, Taylor's wrought-iron, R. G. F., slightly split in rear part of vent piece, 4 inches perpendicular. No damage or accident. |
| 1       | 40 " " " 38 -               | 31                   |                                     |                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1       | 40 " " " 60 -               | 30                   |                                     |                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1       | 40 " " " 170 -              | 30                   |                                     |                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 4       | 1                           | 40 " " " 171 -       | Guns are in good condition.         |                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1       | 12 " " " 37 -               | 36                   |                                     |                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1       | 12 " " " 103 -              | Nothing fired.       |                                     |                                                                                                                                                                                                                                                                                                                                                                                                                         |
|         | (Field piece).              |                      |                                     |                                                                                                                                                                                                                                                                                                                                                                                                                         |

(Signed) W. H. CUMING,  
Acting Commander in temporary charge.

Forwarding a REPORT of the ARMSTRONG GUNS on board H.M.S. "Leopard."

Straits of Simono Seki, Japan,

15th September 1864.

SIR,

I HAVE the honour to enclose in duplicate, in compliance with your order, a detailed report of the performance of the Armstrong guns on board this ship.

The vent pieces, three in number, injured, are all wrought iron, and all similarly cracked; these cracks being all below the circular slot that enters the base of the chamber, I think proves that, from the direction of the vent, the lower portion of the charge is not exploded instantaneously with the upper portion, thereby bringing the strain on the upper half-face of the vent piece. No vent pieces were blown out of the gun.

The 40-pounder, No. 6 on the enclosed list, when fired made a great explosion, lifting the deck from the beams for several feet of the surface above the vent; the gun was temporarily disabled, the vent piece able to be moved but not extracted; the upper edge was "burred," and had to be filed, as also the upper edge of the bore of the chamber; a very slight touch of the file cleared it, and the gun seems uninjured; it had, however, to be changed during the action for its opposite gun.

The range of the 40-pounders was very good indeed, as also of the 110-pounders, and their practice excellent, until the 110-pounder marked No. 2 became, I fancy, leaded near the chamber, when at least the last right shot seemed to strip, and with a loud whirring noise went anywhere; one shot struck the water at long range, and turned at nearly a right angle; all ricochets turned to the right with the Armstrong shot.

The Armstrong 110-pounder guns in H.M.S. "Leopard," on a rear chock carriage, with the exception of one; no breeching was carried away nor breeching bolts drawn; the 68-pounder on a slide started breeching bolts, and

carried away one breeching, but the ship is old. The rear chock carriages are uninjured.

No time fuzes were used with Armstrong shell, only pillar fuzes; three of these burst alongside, one close to the muzzle of the gun; several of these shells were seen to burst, but I believe many did not. The pillar fuzes, as supplied to this ship are, in my opinion, not to be trusted for covering landing parties, nor for firing near other ships.

From the 110-pounder Armstrong marked No. 1 on the list, two or three shots laterly stripped and "wabbled."

In all the practice during the commission of this ship no accident has happened to any Armstrong gun, although many shots have stripped and "wabbled," until during this action, a period of nearly two years. I attribute these accidents recorded to the heating of the guns and vent pieces, the rifling becoming leaded, rendering all aim uncertain. The captains of the guns being chiefly seamen gunners or gunner's mates, the same as throughout the commission.

I do not think it can be put down to careless loading from excitement.

In the face of this positive evidence, I must express my opinion that I do not think the 110-pounder Armstrong gun the gun for sea service, not only for the above recorded faults, but for the immense amount of room required in the ship for the stowage of a comparatively very few rounds per gun, nearly half the ammunition on board when completed for these guns being expended in two hours firing, and that slow and careful firing.

The 68-pounder gun fired more rounds than any of the Armstrong 110-pounders, every shot and every shell telling beautifully. This gun made perfect practice; the breeching it carried away was old. I have, &c.

(Signed) CHARLES LECKIE,  
Captain.

Vice-Admiral  
Sir A. L. Kuper, K.C.B.,  
Commander-in-Chief.

H.M.S. "Leopard," Straits of Simonoseki, 15th September 1864.

RETURN showing in Detail the Number and Description of each Gun, Number of Times fired, with Remarks as to the Efficiency of the Gun, and the Particulars of Accidents which happened during the recent Operations.

| Description of Gun.    | Number.         | Rounds fired. |                |                 | Vent-pieces damaged.                    | Remarks. |
|------------------------|-----------------|---------------|----------------|-----------------|-----------------------------------------|----------|
|                        |                 | Shot.         | Shell, Common. | Shell, Segment. |                                         |          |
| 1. 110-pr. Armstrong - | 273<br>R. G. F. | 19            | —              | 16              | Taylor's W. I.                          | No. 239  |
|                        |                 |               |                |                 | "                                       | 20       |
| 2. 110 pr. " -         | 363<br>R. G. F. | 21            | 30             | —               | "                                       | 39       |
| 3. 110-pr. " -         | 257<br>R. G. F. | 30            | 8              | 7               | —                                       | —        |
| 4. 40-pr. " -          | 275<br>E. O. C. | 43            | 2              | —               | —                                       | —        |
| 5. 40-pr. " -          | 295<br>E. O. C. | 5             | 1              | —               | —                                       | —        |
| 6. 40-pr. " -          | 280<br>E. O. C. | 10            | —              | —               | One vent-piece expanded 40-pr. E. O. C. | —        |
| 7. 40-pr. " -          | 472<br>E. O. C. | 8             | —              | —               | —                                       | —        |

The cast gun did well.

(Signed) CHARLES LECKIE, Captain.



Reporting the ACCIDENTS, &c. which occurred to the  
ARMSTRONG GUNS on board this ship.

H.M.S. "Argus,"

Sir, Simonoseki, 19th September 1864.

IN compliance with your memo. of the 14th instant, I beg to forward you a report in duplicate, relative to the Armstrong guns on board this ship, the number of times they were fired, their efficiency, and the accidents or damage which happened to them, during the late operations against the Japanese batteries.

| Nature of the Gun.  | No. | No. of times fired. |
|---------------------|-----|---------------------|
| 110-pr. Armstrong - | 1   | Nine.               |
| 12-pr. Armstrong -  | 2   | Twenty-eight.       |

Firstly. With reference to the 110-pr. on the third round, after commencing the action, the gun being loaded with common shell, pillar fuze, and a 12-pound charge, the vent piece was split and became so fixed in the slot that for 45 minutes it defied all the efforts of levers, screw-jacks, crow-bars, and sledge-hammers to extricate it, but eventually was freed by the mechanical ingenuity of Mr. Robert Hodge, engineer in charge; a new vent piece was then introduced, which under the same circumstances of loading as before split on the third round after being first used. A third vent piece was then tried, which also split on the second round, and having no further spare vent pieces, the 110-pr. became useless. My opinion regarding

the 110-pr. Armstrong gun, is that no certain dependence can be placed upon it, and I should extremely regret being again dependent on such a gun in action. I also have to observe, that from the stripping of the lead, and the uncertainty of bursting of the pillar fuzes, I found it impossible to cover the landing of the marines and naval brigade with the Armstrong gun.

The 12-pr. Armstrong guns had no accident or damage happen to them, they did their work efficiently but could not be trusted to cover the landing of the marines and naval brigade, on account of the liability of the lead-coating to strip.

(Signed) J. MORESBY,  
Vice-Admiral  
Sir A. L. Kuper, K.C.B.,  
Commander-in-Chief.

#### Forwarding REPORT OF ARMSTRONG GUNS.

H.M.S. "Perseus,"

Sir, Yokohama, 22nd September 1864.

IN accordance with your memo. of the 14th instant, I have the honour to forward a report of the Armstrong guns of this ship; I also enclose a report of the same made to me by Mr. Cockram, gunner of this ship, which is a most able account of their performances.

I have, &c.  
(Signed) AUGUSTUS KINGSTON,  
Vice Admiral  
Sir A. L. Kuper, K.C.B.,  
Commander-in-Chief.

H.M.S. "Perseus," at Yokohama, 22nd September 1864.

REPORT upon the ARMSTRONG GUNS on board H.M.S. "Perseus," in accordance with Commander-in-Chief's General Memorandum, dated 14th September 1864.

| Number. | Description.                                                               | Number of Times fired. | Opinions as to the efficiency of the Guns.                                                                                                                                                                                                                                                                                                                                                                                                                   | Particulars of any Accident or Damage which may have happened to them during the recent Operations in the Straits of Simonosaki.                                                                                                                                                                                                   |
|---------|----------------------------------------------------------------------------|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 30      | E. O. C. 1860<br>Armstrong 40-pounder.<br>31 cwt., 10 feet.                | 33                     | I consider the 40-pounder Armstrong a most efficient gun, if handled by properly trained men, and with proper care. The five 40-pounders of this ship were used successively for three days, and no accident of any kind or any trouble occurred to them. The practice made by the guns was most accurate to the extent of 3,500 yards. The time fuzes were also very accurate up to their full range of 2,400 yards. I have the highest opinion of the gun. | No accident of any kind happened to the guns; two of them were hoisted out of the ship for the purpose of lightening her when on shore without receiving any damage. Circumstances obliged these guns to remain loaded for a full week in wet and rainy weather, and on being discharged subsequently not one of them missed fire. |
| 54      | E. O. C. 1861<br>Armstrong 40-pounder.<br>32 cwt. 1 qr. 9 lbs., 10 feet.   | 12                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                    |
| 63      | E. O. C. 1861<br>Armstrong 40-pounder.<br>32 cwt. 2 qrs., 10 feet.         | 12                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                    |
| 201     | E. O. C. 1861<br>Armstrong 40-pounder.<br>33 cwt. 3 qrs. 14 lbs., 10 feet. | 16                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                    |
| 222     | E. O. C. 1861<br>Armstrong 40-pounder.<br>33 cwt. 3 qrs. 12 lbs., 10 feet. | 22                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                    |

(Signed) AUGUSTUS KINGSTON, Commander.

H.M.S. "Perseus,"

22nd September 1864.

Sir, IN the action at Simonoseki on the 5th, 6th, and 7th inst., I have to report most favourably of the 40-pr. Armstrong guns on board this ship.

The practice itself was both rapid and accurate, and the guns worked admirably, not the slightest delay or accident having occurred to either vent pieces or guns.

A bucket of fresh water was in readiness at each of the guns in the event of the screws working stiff to wash the ends of the breech screws by pouring a little water down the slot, or by taking them out altogether; it was only made use of in one instance, and that was at the pivot gun, where the screw was found to work a little stiff after firing about a dozen rounds, a little water was then applied down the slot to the end of the screw after which a little oil, the screw then worked as easily as at the commencement of the firing.

Ninety-five rounds were fired altogether from the five guns, 80 rounds with shells and 15 with shot. The time fuzes were very good as far as they ranged leaving nothing

to be desired beyond a little longer fuze, so as to ensure the shells bursting at the greatest range it is possible to fire them on board ship.

When firing at long ranges, 2,500 yards and upwards, with time fuzes the shells burst short; the fuzes used were marked from 5° 50' to 6° 10', within those ranges the fuzes acted admirably.

The pillar percussion were used at long ranges and were found very effective; a few did not burst on striking but the majority did.

The escape of gas was not perceivable and match tubes were very little used, not a single miss fire having resulted in their not being used, and no difficulty was experienced in loading, the projectile and charge going home quite easily.

During the whole of the firing, which continued at intervals for three days from the Armstrong guns, neither of the guns were sponged or breech screws removed or cleaned in any way, with the single exception of the pivot gun, and that was done more as an experiment than from any actual necessity at the time for doing it. The captains of the

guns have been questioned about the guns, and they speak very favourably of them and have the greatest confidence in them.

The foregoing remarks are the result of my own observations, having fired and attended at the guns during the greater part of the firing. My own conclusions are that the guns are a decided success every way, and with a moderate amount of care are perfectly safe on board ship and are fully equal to anything required of them.

I remain, &c.

(Signed) CHAS. COCKRAN,

Gunner.

To Capt. A. J. Kingston,  
H.M.S. "Perseus."

#### REPORT ON 110-PR. ARMSTRONG GUN.

H.M.S. "Coquette," Straits of Simonoseki,  
14th September 1864.

SIR,

WITH reference to your memo. of this day's date requesting a report to be made on the Armstrong guns during the late operations at Simonoseki, I have the honour to acquaint you that about 67 rounds of shot and shell were fired from that piece of ordnance, 110-pr. Armstrong guns, 1 in. No.—No. 177, R.G.F.

After the first day's firing, during which period 40 rounds

were fired, the vent piece was discovered to be split on the lower part of the back surface, immediately below the ring, a crack running horizontally across. The lower part of the breech screw was burred, the breech ring split, and also burred, so as to prevent any projectile from being rammed home. The burrs were filed down and a new vent piece substituted the second day, which after about 6 rounds split in the same place. A third vent piece was substituted, and the remaining 21 rounds were fired during the day without any further accident, with the exception of having twice to file down the burrs and the damaged breech ring.

The vent pieces, which are of wrought-iron, are marked No. 154, R.G.F., and 440 A.G.F., and I attribute the splitting of the vent pieces and breech ring to bad metal.

I have to observe that the gun was re-ringed at Yokohama in June last, and that no practice had taken place since that event.

The practice from the gun was very good, and the different projectiles bursting, with one or two exceptions, where required.

The rifling of the gun has sustained no injury.

I have, &c.

(Signed) ARTHUR G. R. ROE,  
Commander.

Vice Admiral,

Sir A. J. Kuper, K.C.B.,  
Commander-in-Chief.



REPORT of EXAMINATION of Three 12-pr. Rifle Guns for Armstrong and Whitworth Committee at Shoeburyness, 18/4/64, and after firing 208 rounds continuous firing, 20/4/64.

No. 38, E.O.C. 12-pr. BREECH-LOADING ARMSTRONG RIFLE GUN.

Dimensions of bore and chamber not altered. Slight flaws in powder chamber at 3½" "Left" and 4" "Right of "up" and "Right of down." These are apparently slight defects or blisters in the steel.

*Examination after firing 208 rounds continuous firing.*—The slight flaws or defects in powder chamber have increased considerably in length, they now having the appearance of slight cracks, measuring from 3" to 3·6" in length "Left," from 3·3" to 4·1" and from 2·1" to 2·8" "Right of up," and from 3·4" to 4·1" "Right of down."

*Breech copper* expanded ·02 of an inch, and worn at seat.

*Breech piece* scored in slot hole by escape of gas. Lever set fast, caused by the keep pin breaking across the spring, causing a burr to be thrown up on the edge of the groove of the breech screw.

*Vent piece No. 1.*, Swedish iron.—Fire hole in face and copper ring very much worn.

*Vent piece No. 2.*, Cammell's steel.—Copper ring very much worn.

*Vent piece, No. 3.*, Swedish iron.—Fire hole in face and copper ring very much worn.

No. 52, E.O.C. 12-pr. MUZZLE-LOADING SHUNT RIFLE GUN.

*Dimensions* of bore not altered. Bore and grooves slightly scored by gas from 8" to 16 inches from end of bore nearly all round.

*Examination after 208 rounds continuous firing.*—Scoring in bore and grooves slightly increased, extending from 8 to 19 inches from end of bore.

No. 264, WHITWORTH MUZZLE-LOADING RIFLE GUN.

*Bore expanded* at 12 inches from bottom ·003 of an inch, but clear from flaws.

*Examination after 208 rounds continuous firing.*—Slight fissures in front of vent, 7 of an inch long, and in rear ·075 of an inch long from edge of copper bouche.

*Very slight dent* in bore at 12½ inches from bottom, Left of up; slight marks on lands from 9·8 to 10·2 down.

21/4/64. RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

REPORT of EXAMINATION of Three 12-pr. Rifle Guns for Armstrong and Whitworth Committee at Shoeburyness, 23rd April 1864.

No. 38, E.O.C. 12-pr. ARMSTRONG BREECH-LOADING RIFLE GUN.

Flaws in bore in the same condition as reported 20/4/64.

No. 52, E.O.C. 12-pr. MUZZLE-LOADING SHUNT RIFLE GUN.

Slight opening or wearing away round the edge of copper bouche. Diameter of vent ·23 of an inch. In other respects the examination is the same as reported 20/4/64.

No. 264, WHITWORTH MUZZLE-LOADING RIFLE GUN.

The vent of this gun has been changed since the last examination, the bottom or cone of the vent having been increased from ·5 to ·6 of an inch in diameter, the front part of the cone has also been cut or filed out in an irregular form, and the copper set into it, by which means the fissure in front of vent has been shortened about ·15 of an inch; the slight fissure in rear of the vent has also been taken out by the enlargement. In other respects the examination is the same as reported 20/4/64.

An impression showing the alteration of the vent was left at Shoeburyness for the information of the Committee.

26/4/64. RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

REPORT of EXAMINATION of Three 12-pr. Competitive Guns for the Armstrong and Whitworth Committee at Shoeburyness, 30/4/64.

No. 38, 12-pr. E.O.C. BREECH-LOADING RIFLE GUN.

Shot chamber expanded about ·002 of an inch. In other respects the examination is the same as reported 23/4/64.

No. 52, 12-pr. ARMSTRONG MUZZLE-LOADING SHUNT RIFLE GUN.

The scoring by escape of gas very much increased, especially in the grooves, which are deepened at the part scored about ·04 of an inch, and extends from 8 to 19 inches from the bottom of bore.

No. 264, 12-pr. MUZZLE-LOADING RIFLE GUN,  
(WHITWORTH).

Slight marks of wearing on bearing side of grooves from 13 to 42 inches from bottom of bore. Fissure in front of vent slightly increased in depth, and to ·75 of an inch in length.

The remarks in reference to the irregular form, and cutting or filing away of the bottom of the cone of the vent in this gun, as reported on examination 23/4/64, should be cancelled, as the impressions taken on the present examination shows the bottom of the vent to be perfectly round, and the fissure in its original form.

The impressions taken 23/4/64 were taken after the gun had been re-bouched, and before it had been fired, so that probably a small portion of the copper had been forced over the edge of the cone and into the portion of the fissure, thus giving the irregular form and the shortening of the fissure, as shown on the impression.

5/5/64. RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

REPORT of EXAMINATION of Three 12-pr. Rifle Guns for Armstrong and Whitworth Committee at Shoeburyness, 16th May 1864.

No. 38, E.O.C., 12-pr. ARMSTRONG BREECH-LOADING RIFLE GUN.

Fissures in powder chamber slightly increased in length, the present length being from 2·9 to 3·7 left, from 3·2 to 4·2, and from 2·1 to 2·9 right of up, and from 3·25 to 4·2 right of down. Slight opening of point of copper ring.

Dimensions of powder and shot chamber as reported 30/4/64.

No. 52, E.O.C. ARMSTRONG MUZZLE-LOADING SHUNT RIFLE GUN.

Bore expanded at 8 inches from bottom ·003 of an inch, slight fissures in front of vent ·2 and ·075 of an inch long.

The scoring in the bore and grooves is also considerably increased in depth, the measurement being as follows:—

|                       |                 |                 |
|-----------------------|-----------------|-----------------|
| Position of groove at | Up depth -      | ·04 of an inch. |
| breech end.           | Right of down - | ·06 „           |
|                       | Left of down -  | ·08 „           |

The depth of the scoring in the bore is ·04 of an inch.

No. 264, WHITWORTH MUZZLE-LOADING RIFLE GUN.

The fissure previously reported in the front of the vent of this gun has been partially filed out since the last examination, but it has apparently increased in depth. There are also two other fissures in front of the vent, which have become more plainly developed with the recent firing. These were observed but not reported on the last examination, as the impressions did not show them very distinctly.

The length of the fissures in front of vent on the present examination is as follows:—

Fissure (previously reported) ·45 of an inch long from edge of bouche.

Fissure recently developed commencing at ·2 and extending to 1·4 inch from edge of bouche, and the other commencing at 1·2 and extending to 2·9 inch from edge of bouche.

The copper bouche projects into the bore about .05 of an inch, and is slightly worn round edge of cone.

Slight scoring by escape of gas from 7 to 11 inches from end of bore on loading side of grooves "up."

Wearing on bearing side of grooves slightly increased.

Expansion in bore at 12 inches from bottom .004 of an inch.

17/5/64.

RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

#### REPORT of EXAMINATION of Three 12-pr. Rifle Guns for Armstrong and Whitworth Committee at Shoe-buryness, 4th June 1864.

##### No. 38, E.O.C. ARMSTRONG BREECH-LOADING RIFLE GUN.

Dimensions and fissures in powder chamber as reported 16th May 1864.

##### No. 52, E.O.C. ARMSTRONG MUZZLE-LOADING SHUNT RIFLE GUN.

Slight fissures in front of vent .3 of an inch long. The scoring by escape of gas has also slightly increased, both in the bore and in the grooves; the depth of the scoring in the bore is about .05 of an inch, and in the grooves as follows:—

|                                           |               |   |   |     |
|-------------------------------------------|---------------|---|---|-----|
| Position of groove at breech end of bore. | Up depth      | - | - | .06 |
|                                           | Right of down | - | - | .08 |
|                                           | Left of down  | - | - | .09 |

Dimensions of bore as reported 16th May 1864.

##### No. 264, WHITWORTH MUZZLE-LOADING RIFLE GUN.

Fissures in front of vent increased in length about .1 of an inch. The copper bouche projects into the bore about .1 of an inch, and a lip of copper left in front covers the fissure reported 16/5/64 as .45 of an inch long; the bottom of copper bouche is also increased from .7 of an inch to 1.2 in diameter. In other respects the gun is in the same condition as reported 16th May 1864.

RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

#### 12-pr. MUZZLE-LOADING GUNS—ARMSTRONG'S.

No. 51. Proved at Elswick 30th April 1863, with one round of 1½ lbs., two of 2 lbs., and three of 3 lbs., and cast-iron shot 12 lbs.

No. 52. Proved at Elswick 6th May 1863. Same proof as No. 51.

No. 57. Proved at Elswick 9th May 1863. Same proof as No. 51.

#### 12-pr. BREECH-LOADING GUNS—ARMSTRONG'S.

No. 38. Proved at Elswick 12th March 1863, with one round of 1½ lbs., four of 2 lbs., and five of 3 lbs., and service shot 12 lbs.

No. 53. Proved at Elswick 6th May 1863, with one round of 1½ lbs., two of 2 lbs., and three of 3 lbs., and service shot 12 lbs.

No. 61. Proved at Elswick 19th May 1863, with one round of 1½ lbs., two of 2 lbs., and three of 3 lbs., and service shot 12 lbs.

#### 12-pr. MUZZLE-LOADING GUNS—WHITWORTH'S.

No. 251. Proved at Woolwich 4th November 1863, with two rounds of 1½ lbs. and cylinders 24 lbs., and three rounds of 2 lbs., and service shot 12 lbs.

No. 253. } Same as No. 251.  
No. 264. }

9/6/64.

RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

#### REPORT of EXAMINATION of Three 12-pr. Rifle Guns for Armstrong and Whitworth Committee at Shoe-buryness, 11th June 1864.

##### No. 38, E.O.C. ARMSTRONG BREECH-LOADING RIFLE GUN.

Fissure in powder chamber "left" increased about .5 of an inch in length; the remainder as before.

Slight opening of point of copper ring. A considerable amount of expansion has also taken place in the bore of this gun, commencing immediately in front of the shot

chamber, and extending to about 30 inches from the slot hole. The diameter is as follows:—

|                                                                    |                                               |   |   |   |        |
|--------------------------------------------------------------------|-----------------------------------------------|---|---|---|--------|
| Diameter in bore and shot chamber (distance taken from slot hole). | At 10½" in shot chamber                       | - | - | - | 3.066  |
|                                                                    | " 12 "                                        | - | - | - | 3.067  |
|                                                                    | " 13½ in front of shot chamber                | - | - | - | 3.029  |
|                                                                    | " 15 "                                        | - | - | - | 3.039  |
|                                                                    | " 16 "                                        | - | - | - | 3.035  |
|                                                                    | " 17 "                                        | - | - | - | 3.024  |
|                                                                    | " 18 "                                        | - | - | - | 3.016  |
|                                                                    | " 19 "                                        | - | - | - | 3.011  |
|                                                                    | " 20 "                                        | - | - | - | 3.008  |
|                                                                    | " 21 "                                        | - | - | - | 3.0085 |
|                                                                    | " 22 "                                        | - | - | - | 3.011  |
|                                                                    | " 23 "                                        | - | - | - | 3.013  |
|                                                                    | " 24 "                                        | - | - | - | 3.016  |
|                                                                    | " 25 "                                        | - | - | - | 3.016  |
|                                                                    | " 26 "                                        | - | - | - | 3.013  |
|                                                                    | " 27 "                                        | - | - | - | 3.009  |
|                                                                    | " 30 "                                        | - | - | - | 3.007  |
|                                                                    | " 9 from muzzle                               | - | - | - | 3.007  |
|                                                                    | " 2 "                                         | - | - | - | 3.002  |
|                                                                    | Diameter of bottom of grooves in shot chamber | - | - | - | 3.087  |
|                                                                    | " at 15" or 1½" in front                      | - | - | - | 3.118  |
|                                                                    | " at muzzle                                   | - | - | - | 3.084  |

This enlargement was noticed after firing the 208 rounds rapid firing 19/4/64, but was not reported, as it was considered to be the construction of the gun, from the fact of the shot chamber not having altered in the least, and the enlargement of the bore being so immediately in front of it, but this has increased slightly since.

##### No. 52, E.O.C. ARMSTRONG MUZZLE-LOADING SHUNT RIFLE GUN.

Fissure in front of vent slightly increased in depth, but not in length. The scoring by escape of gas has also slightly increased both in the bore and grooves; the greatest depth of the scoring in the bore is about .07 of an inch, and in the grooves as follows:—

|                                           |               |   |   |           |
|-------------------------------------------|---------------|---|---|-----------|
| Position of groove at breech end of bore. | Up            | - | - | about .08 |
|                                           | Right of down | - | - | .1        |
|                                           | Left of down  | - | - | .12       |

Bearing side of edges of grooves slightly worn at seat of shot.

##### No. 264, WHITWORTH MUZZLE-LOADING RIFLE GUN.

Fissures in front of vent slightly increased in length and in depth. There are also a number of fine sharp fissures and slight scoring extending from front of vent to 9½ inches in the same groove; these have appeared since the last examination. The scoring by escape of gas from 7 to 11 inches right of up, and the wearing on the bearing side of the groove have also slightly increased.

RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

#### REPORT of EXAMINATION of Armstrong and Whitworth Experimental Rifle Guns for Armstrong and Whitworth Committee at Shoeburyness, 18th, 20th, and 21st June 1864.

##### No. 38 A, E.O.C. 12-pr. ARMSTRONG BREECH-LOADING RIFLE GUN.

Slight fissures in powder chamber .2 of an inch long from edge of copper ring right of down; this has been developed since the last examination. In other respects the gun is in the same condition as reported June 11th, 1864.

##### No. 52 A, E.O.C. 12pr. ARMSTRONG MUZZLE-LOADING SHUNT RIFLE GUN.

Scoring by escape of gas slightly increased both in bore and grooves. Dimensions in bore and fissure in front of vent as reported June 11th, 1864.

##### No. 264 A, WHITWORTH 12-pr. MUZZLE-LOADING RIFLE GUN.

Fissures and scoring very slightly increased; in other respects the gun is in the same condition as reported June 11th, 1864.

##### No. 53 B, E.O.C. 12-pr. ARMSTRONG BREECH-LOADING RIFLE GUN.

Shot chamber expanded .002 of an inch; bore expanded at 14½ inches from slot hole, or immediately in front of shot chamber, .015 of an inch. The bore is also deeply dented and scored all round by bursting of shell from 51 to 58½ inches from muzzle, and slightly from 10 to 10½ Lt., 11½ to 11½ R. of up, 13½ to 14 Lt., 14½ to 19½ L. of D., 18 to 19 up, 18½ to 19½ R. of up, 19½ to 21 L. of up, 21 to 22 R. of



D.,  $21\frac{1}{2}$  to  $24\frac{1}{2}$  L. of D., 22 to  $24\frac{1}{2}$  L. of up, 23 to 28 R. of up,  $25\frac{1}{2}$  to 26 R. of D.,  $25\frac{1}{2}$  to  $28\frac{1}{2}$  L. of up to up,  $25\frac{1}{2}$  to  $26\frac{1}{2}$  D.,  $26\frac{1}{2}$  to  $27\frac{1}{2}$  L.,  $27\frac{1}{2}$  to  $29\frac{1}{2}$  L. of up,  $28\frac{1}{2}$  to  $29\frac{1}{2}$  Lt.,  $28\frac{1}{2}$  to  $29\frac{1}{2}$  Rt.,  $29\frac{1}{2}$  to 31 L. of up, 30 to 31 D.,  $30\frac{1}{2}$  to  $32\frac{1}{2}$  R. of up,  $30\frac{1}{2}$  to  $31\frac{1}{2}$  up, 32 to 38 Lt. and L. of up, 33 to 34 D., 33 to  $35\frac{1}{2}$  R. of up,  $33\frac{1}{2}$  to  $34\frac{1}{2}$  L. of up,  $34\frac{1}{2}$  to 36 R. of D.,  $34\frac{1}{2}$  to 38 L. of up, 37 to  $40\frac{1}{2}$  R. to R. of D.,  $38\frac{1}{2}$  to 43 L. of up,  $40\frac{1}{2}$  to  $41\frac{1}{2}$  L. of up,  $41\frac{1}{2}$  to  $43\frac{1}{2}$  L. of D., 42 to 48 R. to R. of D.,  $43\frac{1}{2}$  D., 44 to  $47\frac{1}{2}$  R. of D.,  $46\frac{1}{2}$  to  $47\frac{1}{2}$  L. of D., 48 to  $49\frac{1}{2}$  L. of D., 48 to  $50\frac{1}{2}$  R. of up to R. of D.,  $49\frac{1}{2}$  to  $50\frac{1}{2}$  L. of D.

No. 51B, E.O.C. 12-pr. ARMSTRONG MUZZLE-LOADING SHUNT RIFLE GUN.

Bore expanded at 8 inches from bottom of bore .003. Slight fissure in front of vent .2 of an inch long from edge of copper bouche. Bore dented and scored by bursting of shell from  $1\frac{1}{2}$  to  $3\frac{1}{2}$  Rt. in groove from  $6\frac{1}{2}$  to  $7\frac{1}{2}$  R. of D., 8 to 9 R. and R. of D.,  $10\frac{1}{2}$  to  $11\frac{1}{2}$  R. of up,  $10\frac{1}{2}$  to  $13\frac{1}{2}$  up in groove,  $14\frac{1}{2}$  to 15 R. and R. of D.,  $14\frac{1}{2}$  to  $15\frac{1}{2}$  R. of up,  $15\frac{1}{2}$  to  $17\frac{1}{2}$  R.,  $16\frac{1}{2}$  to  $18\frac{1}{2}$  R. of D. in groove, 17 to 18 R. of D., 20 to 21 R.,  $21\frac{1}{2}$  to  $23\frac{1}{2}$  R. of D.,  $28\frac{1}{2}$  to  $29\frac{1}{2}$  R. of up on edge of groove, 31 to  $31\frac{1}{2}$  L. of D.,  $32\frac{1}{2}$  to 33 L. of D.,  $33\frac{1}{2}$  to 35 L. of up on edge of groove, 36 to 37 D.,  $36\frac{1}{2}$  to 38 L.,  $37\frac{1}{2}$  to  $38\frac{1}{2}$  R. of up,  $42\frac{1}{2}$  L. of D.,  $44\frac{1}{2}$  to  $46\frac{1}{2}$  L. of up on edge of groove, and from  $46\frac{1}{2}$  to  $49\frac{1}{2}$  all round.

No. 251B, 12-pr. WHITWORTH MUZZLE-LOADING RIFLE GUN.

Slight tool marks in bore from muzzle to 1" R. of up and L. of D., from 8 to  $10\frac{1}{2}$ , from 17 to  $19\frac{1}{2}$ , from  $26\frac{1}{2}$  to  $28\frac{1}{2}$ , from  $35\frac{1}{2}$  to  $37\frac{1}{2}$ , from  $44\frac{1}{2}$  to  $46\frac{1}{2}$ , and from  $53\frac{1}{2}$  to  $54\frac{1}{2}$  R. of up, from 8 to 10, from 17 to  $18\frac{1}{2}$ , from  $35\frac{1}{2}$  to  $37\frac{1}{2}$ , from  $44\frac{1}{2}$  to  $46\frac{1}{2}$ , and at 54 L. of D. These were all in the gun before proof.

Bore slightly marked by bursting of shell at  $50\frac{1}{2}$  "Right," "Down," and "Left," and at  $51\frac{1}{2}$  Rt.

RICH. K. FREETH, Major, R.A.,

Inspector of Ordnance.

23/6/64.

REPORT OF EXAMINATION of 12-pr. Armstrong and Whitworth Rifle Guns, for Armstrong and Whitworth Committee at Shoeburyness, from 4th to 9th July 1864.

No. 38A, E.O.C. ARMSTRONG BREECH-LOADING RIFLE GUN.

No. 52A, E.O.C. ARMSTRONG MUZZLE-LOADING RIFLE GUN.

No. 264A, WHITWORTH MUZZLE-LOADING RIFLE GUN.

There is no alteration in these guns, the examination will therefore be the same as reported 21st June 1864.

RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

No. 33, 12-pr. E.O.C. BREECH-LOADING RIFLE.

Proved at Elswick, 12th March 1863.

Received from Elswick, 16/10/63, without further proof.

No. 51, 12-pr. E.O.C. MUZZLE-LOADING SHUNT RIFLE.

Proved at Elswick, 30th April 1863.

Received from Elswick, 16/10/63, without further proof.

No. 52, 12-pr. E.O.C. MUZZLE-LOADING SHUNT RIFLE.

Proved at Elswick, 6th May 1863.

Received from Elswick, 16/10/63, without further proof.

No. 53, 12-pr. E.O.C. BREECH-LOADING RIFLE.

Proved at Elswick, 6th May 1863.

Received from Elswick, 16/10/63, without further proof.

No. 57, 12-pr. E.O.C. MUZZLE-LOADING SHUNT RIFLE.

Proved at Elswick, 9/5/63.

Received from Elswick, 16/10/63, without further proof.

No. 61, 12-pr. E.O.C. BREECH-LOADING RIFLE.

Proved at Elswick, 19/5/63.

Received from Elswick, 16/10/63, without further proof

No. 251, 12-pr. MUZZLE-LOADING WHITWORTH GUN.

Received from Mr. Whitworth, 29/10/63.

Proved at Woolwich, 4/1/63.

Returned to Mr. Whitworth for alteration, 13/11/63.

Received from Mr. Whitworth, 18/1/64.

No. 253, 12-pr. MUZZLE-LOADING WHITWORTH GUN.

Received from Mr. Whitworth, 15/10/63.

Proved at Woolwich, 4/1/63.

Returned to Mr. Whitworth for alteration, 13/11/63.

Received from Mr. Whitworth, 18/3/64.

No. 264, 12-pr. MUZZLE-LOADING WHITWORTH GUN.

Received from Mr. Whitworth, 15/10/63.

Proved at Woolwich, 4/1/63.

Returned to Mr. Whitworth for alteration, 13/11/63.

Received from Mr. Whitworth, 18/3/64.

RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

14/7/64.

12-pr., No. 264A, WHITWORTH MUZZLE-LOADING RIFLE GUN.

There does not appear to be any increase either in the scoring or expansion in this gun since last examination, 5/7/64. The total amount of expansion in the bore since the commencement of the firing is as follows:—

|                                |   |   |      |
|--------------------------------|---|---|------|
| At bottom of bore              | - | - | .002 |
| " 3 inches from bottom of bore | - | - | .003 |
| " 6 "                          | " | " | .003 |
| " 9 "                          | " | " | .004 |
| " 12 "                         | " | " | .004 |
| " 15 "                         | " | " | .004 |
| " 18 "                         | " | " | .002 |
| " 21 "                         | " | " | .002 |
| " 24 "                         | " | " | .001 |

12-pr., No. 52A, E.O.C. MUZZLE-LOADING SHUNT GUN.

The scoring in bore and grooves slightly increased in depth.

The wear on the driving side of grooves also slightly increased.

Fissure in front of vent not increased.

The total amount of expansion in the bore since the commencement of the experiment is as follows:—

|                                 |   |   |      |
|---------------------------------|---|---|------|
| At 6 inches from bottom of bore | - | - | .001 |
| " 7 "                           | " | " | .003 |
| " 8 "                           | " | " | .003 |
| " 9 "                           | " | " | .002 |

12-pr., No. 38A, E.O.C. BREECH-LOADING RIFLE GUN.

Slight fissures in powder chamber starting from point of copper ring increased to .3 of an inch; in other respects the gun is in the same condition as 11/6/64.

12-pr., No. 251B, WHITWORTH MUZZLE-LOADING RIFLE GUN.

This gun is precisely in the same condition as reported 21/6/64.

12-pr., No. 51B, E.O.C. MUZZLE-LOADING SHUNT GUN.

Slight scoring in grooves extending about 9 inches from end of rifling, and in bore from  $10\frac{1}{2}$  to 14 inches Right of up.

Fissure in front of vent .2 long not increased.

Denting and scoring from bursting of shell as before.

12-pr., No. 53B, E.O.C. BREECH-LOADING RIFLE GUN.

Defects in bore from bursting of shell as before.

Powder and shot chamber slightly expanded as follows:—

|                  |                                     |   |      |
|------------------|-------------------------------------|---|------|
| Powder chamber   | At $1\frac{1}{4}$ " from breech end | - | .001 |
|                  | " 3 "                               | - | .006 |
|                  | " 4 "                               | - | .002 |
|                  | " 8 "                               | - | .004 |
| Shot chamber     | Muzzle end                          | - | .002 |
|                  | Breech end                          | - | .002 |
| Bore expanded at | $14\frac{1}{2}$ from slot hole      | - | .020 |

C. M. MALONY, Lieutenant R.A.,  
For Inspector of Ordnance.

23/9/64.

REPORT OF EXAMINATION of Six 12-pr. Rifle Guns for Armstrong and Whitworth Committee at Shoeburyness, 8th to 14th December 1864.

No. 38A, E.O.C. BREECH-LOADING RIFLE GUN, (12-pr.)

Slight fissure in P.C. from 1.95 to 2.5 R. of D.; in other respects the flaws and dimensions are the same as reported 11/6/64 and 19/9/64.

No. 52A, E.O.C. MUZZLE-LOADING SHUNT RIFLE GUN, (12-pr.)

The scoring in bore and grooves has slightly increased.

The dimensions the same as reported 19/9/64.

No. 264A, WHITWORTH MUZZLE-LOADING RIFLE GUN, (12-pr.)

The same as reported 19/9/64.

A considerable deposit of powder and flannel cartridge in end of bore.

No. 53B, E.O.C. BREECH-LOADING RIFLE GUN, (12-pr.)

No alteration in dents and scores.

The shot chamber has expanded .001, and the bore at  $14\frac{1}{2}$  from slot hole .002 of an inch. The joint of copper ring has opened, and the copper slightly expanded.

No. 51b, E.O.C. MUZZLE-LOADING SHUNT RIFLE GUN,  
(12-pr.)

Slight fissure in bore from 6·2 to 6·7 R., and from 15 to 15·75 R. of up.

The scoring in the grooves has slightly increased, and is from 8 to 15 in. nearly all round.

The fissure in front of vent not altered.

No. 251b, WHITWORTH MUZZLE-LOADING RIFLE-GUN,  
(12-pr.)

The bore has expanded at 12" from bottom ·001

" " 13 " ·001

" " 15 " ·002

" " 18 " ·001

The marks and dents are in the same condition as reported 21/6/64.

REPORT OF EXAMINATION OF 12-pr. Competitive Rifle Guns for Armstrong and Whitworth Committee on return from Shoeburyness, after firing 2,800 rounds, 21st February 1865.

12-pr. No. 38A, E.O.C. BREECH-LOADING ARMSTRONG GUN.

Slight fissures in powder chamber from 1·95 to 2·5, from 3·25 to 4·2, and from edge of copper ring to ·3 of an inch, R. of D. from 2·5 to 3·7, Left from 3·2 to 4·2, and from 2·1 to 2·9, R. of up.

Breech-piece considerably scored in slot hole by escape of gas, round vent-piece.

Bore and shot chamber expanded, the dimensions and enlargement being as follows:—

|                             |                      |       | Enlargement during Experiment. |
|-----------------------------|----------------------|-------|--------------------------------|
| Diameter in powder chamber. | At 1½ from vent seat | 3·204 | Nil.                           |
|                             | " 4 "                | 3·203 | Nil.                           |
|                             | " 8 "                | 3·201 | Nil.                           |
| Diameter in shot chamber.   | " 10½ "              | 3·607 | ·002                           |
|                             | " 12 "               | 3·608 | ·003                           |
|                             | " 13½ "              | 3·029 | ·029                           |
|                             | " 15 "               | 3·039 | ·039                           |
|                             | " 16 "               | 3·036 | ·036                           |
|                             | " 17 "               | 3·024 | ·017                           |
|                             | " 18 "               | 3·016 | ·009                           |
|                             | " 19 "               | 3·012 | ·005                           |
|                             | " 20 "               | 3·01  | ·003                           |
|                             | " 21 "               | 3·01  | ·003                           |
| Diameter in bore.           | " 22 "               | 3·012 | ·005                           |
|                             | " 23 "               | 3·013 | ·006                           |
|                             | " 24 "               | 3·016 | ·009                           |
|                             | " 25 "               | 3·016 | ·009                           |
|                             | " 26 "               | 3·015 | ·008                           |
|                             | " 27 "               | 3·011 | ·004                           |
|                             | " 30 "               | 3·008 | ·001                           |
|                             | " Muzzle             | 3·002 | Nil.                           |

12-pr. No. 52A, E.O.C., MUZZLE-LOADING SHUNT RIFLE GUN.

Bore and grooves very much scored by escape of gas, the scoring in bore extending from 8 to 17 inches all round, and in the grooves from 7½ to 19 inches from bottom of bore. The depth in grooves being about ·2 of an inch.

The deepest part of the scoring in the bore is from "R. of up" to "L. of up," and in the grooves "R. of D." and "L. of D." at breech end of bore, slight amount of wear on bearing or driving side of grooves.

Slight fissures in front of vent, ·3 of an inch in length, there is also a slight amount of wear round the edge of copper bouch, extending nearly ·1 of an inch in depth, diameter of vents top ·22, bottom ·3 of an inch.

Very slight amount of expansion in bore, the dimensions and enlargement being as follows:—

|                   |                 |       | Enlargement during Experiment. |
|-------------------|-----------------|-------|--------------------------------|
| Diameter of bore. | At bottom       | 2·99  | Nil.                           |
|                   | " 1 from bottom | 2·99  | Nil.                           |
|                   | " 2 "           | 2·991 | Nil.                           |
|                   | " 3 "           | 2·996 | Nil.                           |
|                   | " 4 "           | 2·997 | Nil.                           |
|                   | " 5 "           | 2·997 | Nil.                           |
|                   | " 6 "           | 2·998 | ·001                           |
|                   | " 7 "           | 3·001 | ·003                           |
|                   | " 8 "           | 3·002 | ·003                           |
|                   | " 9 "           | 3·001 | ·001                           |
| Diameter of bore. | " Muzzle        | 3·02  | Nil.                           |

12-pr. No. 264A, WHITWORTH MUZZLE-LOADING RIFLE GUN.

Bore slightly scored by escape of gas from front of vent, extending to 15 inches from bottom of bore "R. of up" to "L. of up."

Slight fissures in front of vent, extending to 2·5 inches in length; slight opening round cone of vent, the deepest part being in the rear, at which part the impression shows the defect to be about ·1 of an inch in depth.

Slight amount of wear on bearing side of rifling, extending from 13 to 45 inches from bottom of bore.

There is also a slight amount of expansion in the bore, the dimensions and enlargement being as follows:—

|                   |                       |       | Enlargement during Experiment. |
|-------------------|-----------------------|-------|--------------------------------|
| Diameter in bore. | At bottom of bore     | 3·025 | ·005                           |
|                   | 3 from bottom of bore | 3·025 | ·005                           |
|                   | 6 "                   | 3·028 | ·008                           |
|                   | 9 "                   | 3·025 | ·005                           |
|                   | 12 "                  | 3·025 | ·005                           |
|                   | 15 "                  | 3·024 | ·004                           |
|                   | 18 "                  | 3·024 | ·004                           |
|                   | 21 "                  | 3·023 | ·003                           |
|                   | 24 "                  | 3·022 | ·002                           |
|                   | 27 "                  | 3·022 | ·002                           |
| Diameter in bore. | " Muzzle              | 3·02  | —                              |

12-pr. No. 53B, E.O.C. BREECH-LOADING ARMSTRONG RIFLE GUN.

Exterior.

Blow from shot at 40 inches from muzzle, Rt.; this has cut a piece out of the 3 C. coil 2·75 × 3 inches, and has also cracked the coil longitudinally 2·75 inches from edge; there is also a slight blow from shot on 3 "C" coil at 14 inches "L. of up". The blow at 40 inches "Rt." has expanded the 3 "C" coil, causing an opening between the coil and "A" tube extending nearly all round, the widest part being ·7 of an inch R. of D. The "A" tube is also dented about ·1 of an inch in depth, causing a corresponding bulge in the bore.

Interior.

The dents and scores in bore by bursting of shell from muzzle to shot chamber as in former report. There is a slight flaw in bore in centre of bulge at 40 inches "Rt."

Bore and chamber slightly expanded, the present dimensions and enlargement being as follows:—

|                                            |                      |       | Enlargement during Experiment. |
|--------------------------------------------|----------------------|-------|--------------------------------|
| Diameter in powder chamber.                | At 1½ from vent seat | 3·21  | ·002                           |
|                                            | " 3 "                | 3·218 | ·007                           |
|                                            | " 4 "                | 3·213 | ·002                           |
|                                            | " 8 "                | 3·214 | ·007                           |
|                                            | " 10½ "              | 3·068 | ·003                           |
| Diameter in shot chamber.                  | " 12 "               | 3·068 | ·003                           |
|                                            | " 14½ "              | 3·024 | ·024                           |
|                                            | " 20½ "              | 3·021 | ·014                           |
| Diameter in bore.                          | " 22 "               | 3·01  | ·003                           |
|                                            | " 24 "               | 3·008 | ·001                           |
| Diameter at 40½ from muzzle and under dent |                      |       | 2·95 bulge                     |
|                                            |                      |       | Contraction of Bore. ·057      |

Edge of groove for keep pin in breech screw is slightly burred up.

After firing three rounds at proof butt 10/2/65, no alteration was found in any of the defects.

The delay caused by fitting of lever at proof butt on the 10th February was caused by a wrong lever being sent to the butt with the gun. The lever used did not belong to either of the experimental guns, but was a spare one from the President of Ordnance Department.

12-pr. No. 51b E.O.C. MUZZLE-LOADING SHUNT GUN.

Exterior.

Blows from shot on chase at 9½ inches from muzzle "R. of up," the deepest part of dent being about ·05 of an inch, causing a corresponding bulge in the bore; and at 25½ "R," the deepest part being about ·04 of an inch, also causing a bulge in the bore. Shoulder of right trunnion grazed "R. of up" and "R. of D." and also on face of trunnion and slight grazes on trunnion hoop, at 41½ "R. and 41·9 L."; trunnion sight broken off.

Interior.

Slight scoring by gas, in grooves, extending from 8 to 17 inches from bottom of bore, and in lands from 10½ to



14 "R. of up." Slight fissures in front of vent '2 of an inch in length and in bore from 6'2 to 6'7 of an inch right, and from 15 to 15'75 "R. of up."

Slight amount of expansion in bore, the dimensions and enlargement being as follows :—

|                   |                                   |   |             | Enlargement during Experiment. |
|-------------------|-----------------------------------|---|-------------|--------------------------------|
| Diameter of bore. | At bottom                         | - | 2'99        | - Nil.                         |
|                   | 1½ from bottom                    | - | 2'988       | - Nil.                         |
|                   | 3                                 | " | 2'991       | - Nil.                         |
|                   | 6                                 | " | 2'997       | - Nil.                         |
|                   | 7                                 | " | 3'002       | - '002                         |
|                   | 8                                 | " | 3'004       | - '001                         |
|                   | 9                                 | " | 3'006       | - '001                         |
|                   | 12                                | " | 3'008       | - '004                         |
|                   | 15                                | " | 3'005       | - '003                         |
|                   | 18                                | " | 3'002       | - '002                         |
|                   | 21                                | " | 3'001       | - '001                         |
|                   |                                   |   |             | Contraction of Bore.           |
| Diameter in bore. | At 9" from muzzle and under dent  | - | 2'961 bulge | '039                           |
|                   | At 25" from muzzle and under dent | - | 2'963 "     | '037                           |

Diameter of vent, top '23, bottom '4 of an inch.  
The bulging in bore is sufficient to prevent the shot in which the studs are, of the full dimensions, from passing down without using force.

After firing three rounds at proof butt 10/2/65, no alteration was found in any of the defects.

12-pr. No. 251B, WHITWORTH MUZZLE-LOADING RIFLE GUN.

Exterior.

Slight dents on chase at 25½ inches "up" and 26½ "R. of D.," about '02 of an inch deep.

Trunnion hoop off gun.  
Left trunnion broken out of hoop; the hoop is also split in two places, in the interior "R. of D." and "R. of up."

Interior.

Slight scoring in bore, extending 3 inches from front of vent, and slight fissure in front of vent '5 of an inch in length. There was also a considerable opening round the cone of copper bouch, the gutta-percha penetrating about '5 of an inch all round the cone, and on removing one of the impressions, the lower part of the vent was brought out with it. This shows there has been a considerable escape of gas, as the copper is very much corroded round the cone and on one side of the stem.

There is also a slight expansion in the bore, the dimensions and enlargement being as follows :—

|                   |                       |   |       | Enlargement during Experiment. |
|-------------------|-----------------------|---|-------|--------------------------------|
| Diameter of bore. | At bottom of bore     | - | 3'024 | - Nil.                         |
|                   | 3 from bottom of bore | - | 3'024 | - Nil.                         |
|                   | 6                     | " | 3'024 | - Nil.                         |
|                   | 9                     | " | 3'024 | - Nil.                         |
|                   | 12                    | " | 3'025 | - '001                         |
|                   | 13                    | " | 3'026 | - '001                         |
|                   | 15                    | " | 3'026 | - '002                         |
|                   | 18                    | " | 3'024 | - '001                         |
|                   | 19                    | " | 3'023 | - Nil.                         |
|                   | Muzzle                | - | -     | - Nil.                         |

Diameter of vent, top '23, bottom '65 of an inch.  
After firing three rounds at proof butt 10/2/65, no alteration was found in any of the defects.

Mem.—This gun will require re-venting.

RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

MEMO. of DIMENSIONS and EXPANSION in BORES of 12-PR. COMPETITIVE RIFLE GUNS while testing for endurance at PROOF BUTT, ROYAL ARSENAL.

No. 52A E.O.C. 12-Pr. Muzzle-loading Shunt Rifle Gun.

No. 264A Whitworth Muzzle-loading Rifle Gun.

| Distance from bottom of Bore. | Diameter and Expansion before testing to Endurance. |            | Diameter and Expansion of Bore while testing for Endurance. |            |                           |            |                           |            |           |            | Remarks.                                                   |
|-------------------------------|-----------------------------------------------------|------------|-------------------------------------------------------------|------------|---------------------------|------------|---------------------------|------------|-----------|------------|------------------------------------------------------------|
|                               |                                                     |            | After 11 Rounds. 24/3/65.                                   |            | After 45 Rounds. 25/3/65. |            | After 10 Rounds. 27/3/65. |            |           |            |                                                            |
|                               |                                                     |            |                                                             |            |                           |            |                           |            |           |            |                                                            |
|                               | Diameter.                                           | Expansion. | Diameter.                                                   | Expansion. | Diameter.                 | Expansion. | Diameter.                 | Expansion. | Diameter. | Expansion. |                                                            |
| ins.                          |                                                     |            |                                                             |            |                           |            |                           |            |           |            | Dimensions of the No. 38 E.O.C. 12-pr. B.L. Gun not taken. |
| 8                             | 3'002                                               | '002       | 3'002                                                       | '002       | 3'04                      | '04        | 3'04                      | '04        |           |            |                                                            |
| 9                             | 3'001                                               | '001       | 3'005                                                       | '005       | 3'045                     | '045       | 3'045                     | '045       |           |            |                                                            |
| 10                            | 3'000                                               | Nil.       | 3'018                                                       | '018       | 3'05                      | '05        | 3'052                     | '052       |           |            |                                                            |
| 11                            | —                                                   | —          | 3'017                                                       | '017       | 3'052                     | '052       | 3'052                     | '052       |           |            |                                                            |
| 12                            | —                                                   | —          | 3'021                                                       | '021       | 3'05                      | '05        | 3'05                      | '05        |           |            |                                                            |
| 13                            | —                                                   | —          | 3'02                                                        | '02        | 3'05                      | '05        | 3'05                      | '05        |           |            |                                                            |
| 14                            | —                                                   | —          | 3'018                                                       | '018       | 3'049                     | '049       | 3'049                     | '049       |           |            |                                                            |
| 15                            | —                                                   | —          | 3'02                                                        | '02        | 3'049                     | '049       | 3'049                     | '049       |           |            |                                                            |
| 16                            | —                                                   | —          | 3'025                                                       | '025       | 3'04                      | '04        | 3'041                     | '041       |           |            |                                                            |
| 17                            | —                                                   | —          | 3'025                                                       | '025       | 3'032                     | '032       | 3'038                     | '038       |           |            |                                                            |
| 18                            | —                                                   | —          | 3'023                                                       | '023       | 3'024                     | '024       | 3'032                     | '032       |           |            |                                                            |
| 19                            | —                                                   | —          | —                                                           | —          | —                         | —          | 3'032                     | '032       |           |            |                                                            |
| 20                            | —                                                   | —          | —                                                           | —          | —                         | —          | 3'03                      | '03        |           |            |                                                            |
| 21                            | —                                                   | —          | —                                                           | —          | —                         | —          | 3'028                     | '028       |           |            |                                                            |

| Distance from Bottom of Bore. | Diameter and Expansion before testing to Endurance. |            | Diameter and Expansion of Bore while testing for Endurance. |            |
|-------------------------------|-----------------------------------------------------|------------|-------------------------------------------------------------|------------|
|                               |                                                     |            |                                                             |            |
|                               | Diameter.                                           | Expansion. | After 45 Rounds. 25/3/65.                                   |            |
|                               |                                                     |            | Diameter.                                                   | Expansion. |
| inches.                       |                                                     |            |                                                             |            |
| 3                             | 3'025                                               | '005       | 3'025                                                       | '005       |
| 6                             | 3'028                                               | '008       | 3'03                                                        | '010       |
| 9                             | 3'025                                               | '005       | 3'025                                                       | '005       |
| 12                            | 3'025                                               | '005       | 3'026                                                       | '006       |
| 15                            | 3'024                                               | '004       | 3'026                                                       | '006       |
| 18                            | 3'024                                               | '004       | 3'025                                                       | '005       |
| 21                            | 3'023                                               | '003       | 3'034                                                       | '014       |
| 24                            | 3'022                                               | '002       | 3'051                                                       | '031       |
| 27                            | 3'022                                               | '002       | 3'04                                                        | '02        |
| 30                            | —                                                   | —          | 3'035                                                       | '015       |
| 33                            | —                                                   | —          | 3'032                                                       | '012       |
| 36                            | —                                                   | —          | 3'026                                                       | '012       |
| 39                            | —                                                   | —          | 3'032                                                       | '003       |
| 42                            | —                                                   | —          | 3'022                                                       | '002       |

7th April, 1865.

R. K. FREETH, Major R.A.,  
Inspector of Ordnance.

Office of Inspector of Ordnance, Royal Arsenal,  
Woolwich, 4th April 1865.

REPORT on testing THREE 12-pr. COMPETITIVE GUNS, viz.,  
Sir W. ARMSTRONG's breech-loading and shunt muzzle-loading gun, and Mr. Whitworth's hexagonal bore rifled gun.

The experiment was conducted on the 23rd, 24th, 27th, and 28th March, in the presence of members of the Committee.

RESULTS.

| Series. | Rounds fired. | Space between Cartridge and Shot. | No. of Shot each Round. | Car- tridges. |           | Pro- jectiles. |           | Remarks.                         |
|---------|---------------|-----------------------------------|-------------------------|---------------|-----------|----------------|-----------|----------------------------------|
|         |               |                                   |                         | Length.       | Weight.   | Length.        | Weight.   |                                  |
| 1       | 11            | ins.                              | 1                       | 1             | ins. lbs. | ins. lbs.      | ins. lbs. | B.L. Shunt } Sir W. Arm- strong. |
| 2       | 5             | 6                                 | 1                       | 1             | 7 1½      | 7 ¾            | 11 ½      |                                  |
| 3       | 5             | 12                                | 3                       | 1             | 9 1½      | 8 ¾            | 12        | Hexagonal. Mr. Whit- worth.      |
| 4       | 5             | 12                                | 6                       | 1             | —         | —              | —         |                                  |
| 5       | 10            | 12                                | 5                       | 2             | —         | —              | —         |                                  |
| 6       | 2             | 12                                | 1                       | 1             | —         | —              | —         |                                  |
| 7       | 6             | 6                                 | 6                       | 2             | —         | —              | —         |                                  |
| 8       | 48            | 6                                 | 6                       | 2             | —         | —              | —         |                                  |

The three guns were tested in the same manner, except the breech-loading Armstrong, when the iron wedge of the six series was omitted.

The trunnion ring of breech-loading Armstrong gun was cracked in the seventh round of the fifth series (the 33rd of the experiment), at the fourth round of the seventh series, and 42nd of the experiment, the opening of the trunnion ring extended about an inch; the A tube underneath was also cracked, rendering the discontinuance of the experiment necessary.

The A tube of Armstrong muzzle-loading shunt gun was cracked in the 16th round of the eighth series, the C coil being found torn open, and lying near to the gun as if it had simply fallen off.

At the 48th round of the eighth series the Whitworth gun burst violently into 11 pieces, the fore part of the gun was thrown forward on the butt, the breech blown to the rear, and other parts dispersed through the cell, one part lodging in the timber work. The fracture of gun passed through the vent in a direct line towards the muzzle, and not in the direction of the rifling, as seen in cast-iron guns rifled on the same principle.

RICHD. K. FREETH, Major R.A.,  
Inspector of Ordnance.

Secretary, Armstrong and Whitworth  
Committee.

REPORT of EXAMINATION of No. 55, E.O.C. 70-pr. breech-loading gun, for Armstrong and Whitworth Committee at Shoeburyness, March 22, 1865.

"Exterior."—"B" tube split longitudinally "L. of up" commencing at 29½ from muzzle, extending to, and apparently passing under, the front end of "C" coil. The fracture is about .05 of an inch in width, 1.25 inches in depth, and from the commencement to "C" coil is 11 inches in length.

"Interior."—The bore has expanded under the fracture in the "B" tube, but there is no appearance of any cracks in the barrel; the expansion extends from 27 to 54 inches; the greatest amount being .023 of an inch at 39 inches from the muzzle. The bore is also very much leaded from the muzzle to 60 inches, the grooves being in some places nearly half filled up.

Diameter of vent:—

Through .25 of an inch,  
Bottom '6 "

RICH. K. FREETH, Major.  
Inspector of Ordnance.

Office of Inspector of Ordnance,  
July 1, 1865.

REPORT of EXPERIMENTAL PRACTICE carried on at the Proof Butt with a muzzle-loading shunt rifled gun, No. 59, in accordance with programme received from the Armstrong and Whitworth Committee, dated 30th March, 1865.

| Dates of Firing.           | No. of Rounds. | Charge. |         | Projectiles.          |         |          |     |
|----------------------------|----------------|---------|---------|-----------------------|---------|----------|-----|
|                            |                | Length. | Weight. | Nature.               | Length. | Weight.  | No. |
| 1865.                      |                | in.     | lbs.    |                       | in.     | lbs. oz. |     |
| 21, 23, 25, 26, 27 April - | 800            | 12.1    | 10      | Hollow head- ed shot. | 12.6    | 71 0     | 695 |
| 1, 3, 4, 5, and 6 May -    |                |         |         | Segment shell.        | 13.1    | 64 6     | 50  |
|                            |                |         |         | Common shell.         | 14.6    | 65 0     | 55  |

The gun had previously fired 2,200 rounds at Shoeburyness, and had an extensive crack 19 inches long extending from the bottom of the bore towards the muzzle through the vent parallel with the axis of the gun.

The vent was of true size at the beginning of the experiment, but an obstruction at 5½ inches from the top prevented the gauge .22 from passing through; at 175th round gauge .22 passed into the bore; at 525th round .23 gauge entered, but at the 662nd round the vent had partially closed, preventing gauge .22 from passing further down than 4.6 inches from the surface, and so continued to end of the experiment.

Lubricators were taken into use at the 242nd round, and continued during the experiment.

The projectiles used had been previously fired at Shoeburyness.

Fifty segment shells were fired which broke up on entering the butt; the fragments scattering about became dangerous, they were therefore discontinued.

Examination after firing.—The crack in "A" tube has slightly increased in length it now extending from bottom of bore to 20 inches "up."

The fissuring and scoring in the grooves and bore has also considerably increased both in length and depth, and the driving edges of the grooves are also very much worn.

The centre of the vent was partially closed at the end of the experiment, but the top and bottom was considerably enlarged; the edge of the copper bouche was very much worn away.

The amount of expansion in bore is as follows:—

|                   | Vertical. | Horizontal. |
|-------------------|-----------|-------------|
| At 3° from bottom | .002      | .002        |
| 6 "               | .003      | .005        |
| 9 "               | .001      | .001        |
| 12 "              | .002      | .002        |
| 15 "              | .001      | .001        |
| 18 "              | .004      | .004        |
| 21 "              | .012      | .010        |
| 22 "              | .008      | .060 Dent.  |
| 27 "              | .007      | .002        |
| 30 "              | .015      | .045 Dent.  |
| 33 "              | .013      | .023        |
| 36 "              | .001      | .005        |

Impressions taken before and after the experiment are forwarded herewith.

1/7/65.

RICH. K. FREETH, Major,  
Inspector of Ordnance.

Office of Inspector of Ordnance,  
July 1, 1865.

REPORT of EXPERIMENTAL PRACTICE carried on at the Proof Butt, with a 70-pr. Armstrong rifled gun, No. 55, for Armstrong and Whitworth Committee, in accordance with programme dated March 30, 1865.

| Dates of Firing.                                     | No. of Rounds. | Charge. |         | Projectiles.          |         |          |     |
|------------------------------------------------------|----------------|---------|---------|-----------------------|---------|----------|-----|
|                                                      |                | Length. | Weight. | Nature.               | Length. | Weight.  | No. |
| 1865.                                                |                | in.     | lb.     |                       | in.     | lbs. oz. |     |
| 18 and 19 April.                                     | 1400           | 12      | 9       | Solid shot.           | 11.56   | 78 8     | 674 |
| 8, 10, 11, 12, 13, 15, 17, 23, 27, 29, 30, 31, May - |                |         |         | Hollow head- ed shot. | 12.2    | 71 0     | 525 |
|                                                      |                |         |         | Common shell.         | 14.6    | 63 11    | 201 |



The gun had previously fired 1,600 rounds at Shoeburyness, was cracked to the extent of 11 inches in the "B" tube, had a slight flaw in breech bouche, and corresponding one in breech stopper.

*Vent.*—Before testing the vent, gauge '24 passed through, was enlarged at the 25th round to '25, at 50th round '24 only would enter; at the 200th round an obstruction to the vent gauge '24 at 5½ inches, but '23 passed through; at 340th round '23 gauge was stopped at the same place, '22 passing the obstruction; at 400th round '22 was also stopped, but the prickler passed freely; at 536th round the obstruction in vent shifted to 4¾ inches from top; at 860th to 4 inches, and at 1,240 round to 2 inches, and continued so to end of experiment.

In consequence of the defective state of the vent a great many misfires took place (at least 16 per cent.) thus delaying the experiment considerably.

*Breech bouche.*—At 200th round the defect in breech bouche was much increased, and a considerable escape of gas ensued; at 201st round a piece of rag placed in the slot of gun was set on fire, the bouche was considered unserviceable.

The gun was then fitted with a new bouche, which remained good until the 536th round when the escape of gas was great, this bouche after firing 335 rounds was considered unserviceable.

At the 537th round the gun was fitted with a new bouche which lasted the remainder of the experiment. The removal of the old bouche and replacing the new one took an artisan and gunner five hours.

*Breech stopper.*—At 201st round escape of gas considerable, the defect was repaired by the insertion of a new piece of metal; after 536th round the stopper was replaced by a new one, which finished the experiment.

*Locking pin and slide.*—After the 200th round the slide for locking pin was broken, the gun was fitted with a new slide and cover, this remained good for the remainder of the experiment.

The crack in "B" tube underwent no perceptible change in the course of firing.

*Firing after 650 rounds.*—To hasten the testing of this gun it was removed from the busting cell to the open platforms, was changed in position after every 100 rounds, and the gun thoroughly washed out, and locking pin and slide cleaned.

The breech stopper was cleaned after every 10th round.

*Examination after firing.*

Scoring at junction of powder and shot chamber slightly increased.

The denting in the bore and the expansion under crack in chase has not increased.

The powder chamber has expanded .005 of an inch, but there is no alteration in the shot chamber.

The exterior crack in "B" tube has not increased. The centre of the vent was partially closed at the end of the experiment, but the top and bottom were very much enlarged.

Breech ring and stopper, no defects.

Impressions taken before and after the experiment are forwarded herewith.

RICH. K. FREETH, Major, R.A.,  
Inspector of Ordnance.

1/7/65.

Office of Inspector of Ordnance.  
July 1, 1865.

REPORT OF EXPERIMENTAL PRACTICE carried on at the Proof Butt, with 70-pr. Whitworth muzzle-loading rifle gun, No. 276, for Armstrong and Whitworth Committee in accordance with Programme, dated 12th May, 1865.

| Dates of Firing.        | No. of Rounds. | Charge. |         | Projectiles. |         |             |
|-------------------------|----------------|---------|---------|--------------|---------|-------------|
|                         |                | Length. | Weight. | Nature.      | Length. | Weight.     |
| 30 and 31 May.          | 998            | 14½     | 10      | Solid shot.  | in. 15  | lbs. 70 943 |
| 2, 5, 8, 9 and 10 June. |                |         |         | Common shell | 20½     | 70 55       |

No. of rounds previously fired at Shoeburyness, 2002.

*Vent.*—Before the commencement of the experiment the '22-inch gauge passed up the vent as far as the platina plug (viz.) 12½ inches from entrance. After firing 209 rounds it was considered necessary to renew the vent. An attempt was made by Mr. Whitworth's artificer to unscrew the unserviceable one, but failed as it could only be partially removed; it was then determined to remove the copper lining of the vent, but as this could not be effectually removed, a service round was fired from the muzzle for the purpose of trying to blow the copper out, but this also failed; it was ultimately drilled out after much labour, and a new copper fitted.

After firing 311 rounds the '22-inch gauge passed through the vent and platina plug. At the 380th round the vent was rimed out before the '22-inch gauge could pass into the bore, but at the 511th round it passed only to the platina plug. At the 710th round the '22-inch gauge stopped at 7 inches; at the 885th at 4 inches, and at the 954th at 6½ inches from entrance.

The vent was rimed out after the 956th round, and the '22-inch gauge passed into the bore, and continued to do so to the end of the experiment. The vent was rimed out after the 380th, 390th, 410th, 460th, 510th, 560th, 610th, 660th, 710th, 760th, 810th, 885th, and 956th rounds. The vent fouled very much throughout the experiment, which necessitated the frequent riming.

The prickler passed through the vent independently of the riming until the 956th round, when it was stopped at the platina plug.

*Plug in upper or original vent.*—At the 510th round copper plug in old vent projected into the bore, and in some degree impeded the loading; a new plug was fitted at the 511th round, this required setting up at the 760th round, and dropped at the 935th, which rendered loading so difficult, that after the 954th round it was removed and a new one fitted.

*Breech plug.*—At the 510th round the cascade or breech plug shifted ⅓ of an inch (circumferentially), and again ⅓ of an inch at 760th round. A slight crack was also observed in the breech at this time .775 of an inch long, but it did not increase with the after firing.

*Examination after firing.*

*Fissures in powder space.*—The fissures in the powder space of bore have considerably increased both in length and depth, they now extending from bottom of bore to 48 inches in length, and in each groove or angle of the rifling. The deepest of these fissures is "up," and the impression shows a depth of about .2 of an inch.

*Scoring.*—The bore is also very much scored by the gas all round, and extending in length from bottom of bore to 48 inches.

*Wear in grooves.*—The impressions show a considerable amount of wear on the driving side of rifling in each groove, extending from 19 to 38 inches from bottom of bore.

*Copper cup in end of bore.*—The copper cup in bottom of bore is very much crushed and distorted in shape, the centre or portion round the vent bouche apparently curling forward, while the part at .75 of an inch from the edge of the cup is crushed back about .3 of an inch.

*Breech plug, &c.*—The breech plug has shifted round 1.1 inches, which causes it to project about .02 of an inch, and there is also a slight crack or defect under sight ring on the right side from muzzle .75 of an inch in length.

The expansion in bore after firing at proof butt, and total expansion, is as follows:—

| Distance from bottom of Bore. | Expansion while firing at Proof Butt. | Total Amount of Expansion. | Distance from bottom of Bore. | Expansion while firing at Proof Butt. | Total Amount of Expansion. |
|-------------------------------|---------------------------------------|----------------------------|-------------------------------|---------------------------------------|----------------------------|
| in. 1                         | .025                                  | .026                       | in. 21                        | .037                                  | .040                       |
| 2                             | .020                                  | .021                       | 22                            | .022                                  | .040                       |
| 3                             | .011                                  | .012                       | 23                            | .015                                  | .034                       |
| 4                             | Nil.                                  | .010                       | 24                            | .006                                  | .020                       |
| 5                             | .003                                  | .008                       | 27                            | .004                                  | .009                       |
| 6                             | .016                                  | .016                       | 30                            | .003                                  | .004                       |
| 7                             | .023                                  | .023                       | 36                            | .001                                  | .001                       |
| 8                             | .025                                  | .030                       |                               |                                       |                            |

Impressions taken before and after the experiment forwarded herewith.

RICH. K. FREETH, Major.  
Inspector of Ordnance.

1/7/65.

Office of Inspector of Ordnance, 13th July 1865.

SECOND REPORT of EXPERIMENTAL PRACTICE with a 70-pr. Competitive Breach-loading Rifled Armstrong Gun (Expl. No. 55) carried out by the Inspector of Ordnance Department for the Armstrong and Whitworth Committee who were present and directed the order of firing.

The gun had previously fired 3,000 rounds as follows :—

At Shoeburyness - - - 2,200  
„ Woolwich - - - 800

| Dates of Firing. | No. of Rounds. | Charge. |                                | Space. | Projectile. |                               |         |                | Recoil. | Remarks.                                                             |
|------------------|----------------|---------|--------------------------------|--------|-------------|-------------------------------|---------|----------------|---------|----------------------------------------------------------------------|
|                  |                | Length. | Weight.                        |        | No.         | Length.                       | Weight. | No. of Rounds. |         |                                                                      |
| 1865.            |                | in.     | lbs.                           |        |             | in.                           | lbs.    |                | ft. in. |                                                                      |
| 30th June        | 60             | 12      | 9                              | 12     | 1           | 7 <sup>3</sup> / <sub>4</sub> | 62      | 10             | 9 5     | Cylinders weighing 128 lbs. each were used and considered as 2 shot. |
|                  |                |         |                                |        | 2           | "                             | "       | 20             | 12 7    |                                                                      |
|                  |                |         |                                |        | 4           | "                             | "       | 20             | 21 10   |                                                                      |
|                  |                |         |                                |        | 7           | "                             | "       | 10             | 26 9    |                                                                      |
|                  |                |         |                                |        | 5           | "                             | "       | 1              | 38 1    |                                                                      |
|                  | 5              | 15      | 13 <sup>1</sup> / <sub>2</sub> | 6      | 6           | "                             | "       | 1              | 44 9    |                                                                      |
|                  |                |         |                                |        | 7           | "                             | "       | 2              | 50 2    |                                                                      |
|                  |                |         |                                |        | 9           | "                             | "       | 1              | 60 0    |                                                                      |
|                  |                |         |                                |        | "           | "                             | "       | 2              | 8 1     |                                                                      |
|                  |                |         |                                |        | "           | "                             | "       | 1              | 60 0    |                                                                      |
| 4th July         | 2              | 12      | 9                              | None.  | 1           | "                             | "       | 2              | 8 1     |                                                                      |
|                  | 21             | 15      | 13 <sup>1</sup> / <sub>2</sub> | 6      | 5           | 16·12                         | 128     | 1              | 60 0    |                                                                      |
| 5th July         | 14             | 15      | 13 <sup>1</sup> / <sub>2</sub> | 12     | 3           | 16·12                         | 128     | 20             | 38 6    |                                                                      |
|                  |                |         |                                |        | 1           | 7·75                          | 62      | 14             | 30 9    |                                                                      |
| Total            | 102            | —       | —                              | —      | —           | —                             | —       | 102            | —       |                                                                      |

A defect in the breech bouche, and a corresponding one in the stopper, was observed during the last 5 rounds of the first day's firing (the 60th of the experiment). After the 65th round a new breech bouche was fitted which lasted to the end of the experiment.

Slight crack in powder chamber from 6<sup>1</sup>/<sub>4</sub> to 6<sup>3</sup>/<sub>4</sub> inches "L of up," this has been developed during the recent firing.

The scoring at the junction of powder and shot chamber has slightly increased. Exterior crack in "B" tube not increased.

The bore in front of shot chamber has slightly expanded, the amount being as follows :—

| Distance from end of Bore.                   | Amount of Expansion.  |        |
|----------------------------------------------|-----------------------|--------|
|                                              | During recent firing. | Total. |
| Powder Chamber                               | Nil.                  | *003   |
| Shot chamber                                 | *001                  | *001   |
| Bore 26 <sup>1</sup> / <sub>4</sub> from end | *004                  | *007   |
| 28                                           | *003                  | *018   |
| 32 <sup>1</sup> / <sub>4</sub>               | *007                  | *120   |
| 37 <sup>1</sup> / <sub>4</sub>               | *002                  | *010   |

Impressions of the defects taken after firing are forwarded herewith.

RICH. K. FREETH, Major,  
Inspector of Ordnance.

Office of Inspector of Ordnance, 13th July 1865.

SECOND REPORT of EXPERIMENTAL PRACTICE with a 70-pr. Competitive Muzzle-loading Rifled Whitworth Gun (Expl. No. 267), carried out by the Inspector of Ordnance Department for the Armstrong and Whitworth Committee, who were present and directed the order of firing.

The gun had previously fired 3,000 rounds as follows :—

At Shoeburyness - - - 2,002  
„ Woolwich - - - 998

| Dates of Firing. | No. of Rounds. | Charge. |         | Space. | Projectile. |                                |         |                | Recoil.                           | Vent.                                         |
|------------------|----------------|---------|---------|--------|-------------|--------------------------------|---------|----------------|-----------------------------------|-----------------------------------------------|
|                  |                | Length. | Weight. |        | No.         | Length.                        | Weight. | No. of Rounds. |                                   |                                               |
| 1865.            |                | n.      | lbs.    | in.    |             | in.                            | lbs.    |                | ft. in.                           |                                               |
| 27th June        | 50             | 14·5    | 10      | 12     | 1           | 12                             | 61      | 10             | 8 11                              | Gauge ·22, } 6·5 in. from surface, stopped at |
|                  |                |         |         |        | 2           | "                              | "       | 20             | 11 8                              |                                               |
|                  |                |         |         |        | 4           | "                              | "       | 20             | 16 4                              |                                               |
|                  |                |         |         |        | 7           | "                              | "       | 10             | 25 2                              |                                               |
| 29th "           | 10             | 14·5    | 10      | 12     | 5           | "                              | "       | 1              | 31 5                              | Vent rimed out.                               |
|                  |                |         |         |        | 6           | "                              | "       | 1              | 33 9 <sup>1</sup> / <sub>2</sub>  |                                               |
|                  |                |         |         |        | 7           | "                              | "       | 3              | 39 10                             |                                               |
|                  |                |         |         |        | 1           | 13 <sup>3</sup> / <sub>4</sub> | 69      | 2              | 7 5                               |                                               |
| 29th "           | 5              | 21      | 15      | 6      | 6           | "                              | "       | 21             | 30 10 <sup>1</sup> / <sub>2</sub> | "                                             |
|                  | 2              | 14·5    | 10      | None.  | 1           | 13 <sup>3</sup> / <sub>4</sub> | 69      | 2              | 7 5                               |                                               |
|                  | 21             | 21      | 15      | 6      | 6           | "                              | "       | 14             | 30 10                             |                                               |
| 6th July         | 14             | 21      | 15      | 12     | 6           | "                              | "       | 14             | 30 10                             | "                                             |
|                  | 2              | 14·5    | 10      | None.  | 1           | 13 <sup>3</sup> / <sub>4</sub> | 69      | 2              | 7 5                               | "                                             |
| Total            | 102            | —       | —       | —      | —           | —                              | —       | 102            | —                                 |                                               |

At the 73rd round the chase shifted forward ·08 of an inch, at 76th round it had increased to ·1", at the 82nd to 17", and at close of experiment to ·22 inch. After the firing two cracks were observed in the hoop in rear of the trunnion ring, extending towards the muzzle 10·5 inches in length, slightly angular in position and about 7·5 inches apart.

After 30 rounds were fired the bore was washed out for the purpose of taking an impression; on resuming the firing 9 mis-fires took place, probably from water getting into the vent. The gun was ultimately discharged by passing a piece of quick match through the vent and firing it. The fissuring and scoring in the bore has considerably increased both in length and depth, it now extending from



bottom of bore to 56 inches in length, in each angle of the rifling the deepest of the fissures being "up," the impression showing a depth of about  $\cdot 3$  of an inch.

The copper cup in bottom of bore is very much distorted in shape; the centre part of the cup is apparently curled forward so much that the rear part projects in front of the end of vent bouche about  $\cdot 1$  of an inch, but at  $\cdot 75$  of an inch from the exterior edge the copper is crushed back about  $\cdot 35$  of an inch, or apparently through the cup in one place. The end of the bouche is also forced back about  $\cdot 25$  of an inch.

The chase and "A" tube has shifted forward from under the hoop, in front of trunnions  $\cdot 2$  of an inch; but whether this is due to elongation of the "A" tube from the large amount of expansion in the bore, or from fracture in rear of the cup, cannot be ascertained without the removal of the breech plug, but there is no apparent fracture in the tube itself.

The hoop in rear of trunnions has split through longitudinally, the whole length of the hoop, in two places "Right of Down" this fracture is over the largest amount of expansion in the bore.

The amount of expansion in the bore during the last firing, and the total amount, is as follows:—

| Distance from Bottom of Bore. | Amount of Expansion. |             |
|-------------------------------|----------------------|-------------|
|                               | During last firing.  | Total.      |
| in.                           |                      |             |
| 15                            | Nil.                 | $\cdot 016$ |
| 18                            | Nil.                 | $\cdot 020$ |
| 21                            | $\cdot 039$          | $\cdot 076$ |
| 24                            | $\cdot 181$          | $\cdot 187$ |
| 27                            | $\cdot 248$          | $\cdot 252$ |
| 30                            | $\cdot 267$          | $\cdot 270$ |
| 33                            | $\cdot 297$          | $\cdot 299$ |
| 36                            | $\cdot 208$          | $\cdot 210$ |
| 39                            | $\cdot 123$          | $\cdot 123$ |
| 42                            | $\cdot 056$          | $\cdot 056$ |
| 45                            | $\cdot 026$          | $\cdot 026$ |
| 48                            | $\cdot 026$          | $\cdot 026$ |
| 51                            | $\cdot 012$          | $\cdot 012$ |
| 54                            | $\cdot 008$          | $\cdot 008$ |
| 57                            | $\cdot 008$          | $\cdot 008$ |

Impressions of the defects taken after firing are forwarded herewith.

RICH. K. FREETH, Major,  
Inspector of Ordnance.

Office of Inspector of Ordnance, 13th July 1865.

SECOND REPORT of EXPERIMENTAL PRACTICE with a 70-pr. muzzle-loading rifled shunt competitive Armstrong gun (Experimental No. 59), carried out by the Inspector of Ordnance Department for the Armstrong and Whitworth Committee, who were present, and directed the order of firing.

The gun had previously fired 3,000 rounds as follows:—

At Shoeburyness - - - 1,600  
At Woolwich - - - 1,400

| Dates of Firing. | No. of Rounds. | Charge.      |         | Space. | Projectile. |                 |                  |                | Recoil. | Vent.                                                            |
|------------------|----------------|--------------|---------|--------|-------------|-----------------|------------------|----------------|---------|------------------------------------------------------------------|
|                  |                | Length.      | Weight. |        | No.         | Length.         | Weight.          | No. of Rounds. |         |                                                                  |
| 1865.            |                | in.          | lbs.    |        |             | in.             | lbs.             |                | ft. in. |                                                                  |
| 26th June        | 60             | 12 $\cdot$ 1 | 10      | 12     | 1           | 8 $\frac{1}{2}$ | 61 $\frac{3}{4}$ | 10             | 9 8     | Gauge $\cdot 22$ ,<br>stopped at } 4 $\cdot$ 1 in. from surface. |
|                  |                |              |         |        | 2           | "               | "                | 20             | 12 9    |                                                                  |
|                  |                |              |         |        | 4           | "               | "                | 20             | 22 4    |                                                                  |
|                  |                |              |         |        | 7           | "               | "                | 10             | 26 7    |                                                                  |
| 27th "           | 5              | 18           | 15      | 6      | 5           | "               | "                | 1              | 31 5    | " 3 $\cdot$ 0 "                                                  |
|                  |                |              |         |        | 6           | "               | "                | 1              | 34 1    |                                                                  |
|                  |                |              |         |        | 7           | "               | "                | 2              | 41 6    |                                                                  |
|                  |                |              |         |        | 10          | "               | "                | 1              | 48 8    |                                                                  |
| 1st July         | 2              | 12 $\cdot$ 1 | 10      | None.  | 1           | "               | "                | 2              | 8 11    | Vent rimed out.<br>" 5 $\cdot$ 75 "                              |
|                  |                |              |         |        | 10          | "               | "                | 1              | 60 0    |                                                                  |
|                  |                |              |         |        | 7           | "               | "                | 20             | 38 6    |                                                                  |
|                  |                |              |         |        | 6           | "               | "                | 14             | 30 9    |                                                                  |
| Total            | 102            | —            | —       | —      | —           | —               | —                | 102            | —       | " 5 $\cdot$ 0 "                                                  |

After firing 65 rounds the gun was fitted with a new vent.

The top coil shifted about  $\cdot 01$  of an inch at the 87th round.

The "A" tube of this gun is split longitudinally in four places, viz.: from bottom of bore to 21 inches "up;" from 11 to 35 inches "R. of up" (this fracture runs along the loading side of the groove from 11 to 28 inches, at which point it crosses the groove and extends to 35 inches on the driving side); from 11 $\frac{1}{2}$  to 36 inches in loading side of groove "L. of up," and from 2 to 27 inches on loading side of groove "down." There are two slight cracks or fissures, one from 8 $\frac{1}{2}$  to 9 $\frac{1}{2}$  inches "left," the other from 3 $\cdot$ 9 to 4 $\cdot$ 5 inches "L. of up" from bottom of bore.

There are also apparently two slight cracks at 26 inches from bottom of bore running in a transverse direction to the axis of the bore, and extending from "R. of up" to "L. of up."

The scoring in the bore has slightly increased. There is a slight defect in the centre of bottom of bore about  $\cdot 05$  of an inch in depth.

The gun has been re-vented previously to the commencement of this series of the experiment; vent true.

The point in rear of trunnion hoop is opened about  $\cdot 01$  of an inch.

The bore is slightly expanded. The amount during recent firing and total amount is as follows:—

| Distance from Bottom of Bore. | Amount of Expansion.  |             |       |
|-------------------------------|-----------------------|-------------|-------|
|                               | During recent firing. | Total.      |       |
| in.                           |                       |             |       |
| 3                             | Nil.                  | $\cdot 002$ |       |
| 6                             | "                     | $\cdot 005$ |       |
| 9                             | $\cdot 002$           | $\cdot 003$ |       |
| 12                            | $\cdot 012$           | $\cdot 014$ |       |
| 15                            | $\cdot 014$           | $\cdot 015$ |       |
| 18                            | $\cdot 021$           | $\cdot 025$ |       |
| 21                            | $\cdot 068$           | $\cdot 080$ |       |
| 22                            | $\cdot 069$           | $\cdot 067$ | Dent. |
| 24                            | $\cdot 027$           | $\cdot 047$ |       |
| 27                            | $\cdot 030$           | $\cdot 037$ |       |
| 30                            | $\cdot 013$           | $\cdot 058$ | Dent. |
| 33                            | $\cdot 001$           | $\cdot 024$ |       |
| 36                            | Nil.                  | $\cdot 005$ |       |

Impressions of the defects taken after firing are forwarded herewith.

RICH. K. FREETH, Major,  
Inspector of Ordnance.

REPORT of EXAMINATION of 12-PR. EXPERIMENTAL AMMUNITION, travelled 200 Miles by Principal Superintendent of Stores, for "Armstrong" and "Whitworth" Committee, and examined by Inspector of Ordnance on the under-mentioned days.

| Description of Stores.                                                           | Examination<br>13th January 1865.                                                                                                                                                                                                                                                                                                                                           | Examination<br>19th January 1865.                                                                                                                                                                                                | Examination<br>2nd February 1865.                                                                                                                                                                                                                                             | Examination after opening<br>Defective Fuzes, &c.                                                                                                                                                                                                                                                                                                                                                                                          | Remarks.                                                                                                                                                                                                                                                                           |
|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Fuzes, time, "Armstrong," Nos. from 1 to 30, packed as for service.              | Nos. 1, 4, 6, 11, 12, 14, 17, 19, 20, 22, 23, 24, 25, and 26, no apparent defects.<br>Nos. 2, 5, 7, 8, 9, 16, 21, 27, and 28, nuts worked loose and caps shifted.<br>Nos. 3, 10, 13, 15, 18, and 29, slight shake in pellet.<br>*No. 30 nut unscrewed about half way up the stem of the fuze. Priming shaken out of neck and out of cap, and paper scale partially defaced. | Nos. 1, 2, 4, 5, 6, 8, 9, 11, 16, 17, 21, 22, 24, 26, 27, and 28, no apparent defects.<br>Nos. 7, 14, 19, 20, and 30, nuts worked loose and caps shifted.<br>Nos. 3, 10, 12, 13, 15, 18, 23, 25, and 29, slight shake in pellet. | Nos. 1, 4, 5, 6, 7, 8, 9, 11, 14, 20, 21, 22, 24, 26, and 27; no apparent defects.<br>Nos. 2 and 30 nut worked loose and cap shifted.<br>Nos. 3, 10, 12, 13, 15, 18, 23, 25, 28, and 29 slight shake in pellet.<br>Nos. 16, 17, and 19, priming in neck partially shaken out. | On examination after opening, it was found that the slight shake in pellet, noticed in previous examination, was not caused by any defect in travelling, but was owing to a very slight amount of play between the pellet and the body of the fuze. The wires for suspending the pellet are not injured, but the needles were all found to be very much corroded, and in two cases (Nos. 6 and 23) the needles are very nearly eaten away. | *This fuze had been packed without waterproof paper bag, and with the tin box unbound.<br><br>The paper bags were in nearly all cases found to be cut by the edge of the cup.<br><br>These fuzes were all re-packed in paper bags, and the tin boxes re-bound at each examination. |
| Fuzes, time, "Boxer's" Nos. from 1 to 40, packed as for service.                 | Nos. 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 15 to 19, and 21 to 40, no apparent defects.<br>Nos. 1, 6, 11, 14, and 20, slight shake in pellet.                                                                                                                                                                                                                                    | Nos. 3, 4, 5, 7, 8, 10, 12, 13, 15 to 19, 21 to 33, and 35 to 40, no apparent defects.<br>Nos. 1, 2, 6, 9, 11, 14, 20, and 34, slight shake in pellet.                                                                           | No alteration                                                                                                                                                                                                                                                                 | On examination of these fuzes after opening, the shake was found to be on the side, the wires for suspending the pellets are not apparently damaged.                                                                                                                                                                                                                                                                                       | —                                                                                                                                                                                                                                                                                  |
| Fuzes, percussion, "Armstrong," Nos. from 1 to 30, packed as for service.        | Nos. 1 to 10, 12 to 28, and 30, no apparent defects.<br>Nos. 11 and 29 slight shake in pellet.                                                                                                                                                                                                                                                                              | Nos. 1, 2, 4, to 10, 12 to 28, and 30, no apparent defects.<br>Nos. 3, 11, and 29, slight shake in pellet.                                                                                                                       | No alteration                                                                                                                                                                                                                                                                 | On examination after opening, the shake noticed in previous examination was found to be side shake in guard ring, and not caused by travelling.                                                                                                                                                                                                                                                                                            | —                                                                                                                                                                                                                                                                                  |
| Fuzes, percussion, "Boxer," Nos. from 1 to 36, packed as for service.            | Nos. 2 to 28, 30, 31, 33 to 36, no apparent defects.<br>Nos. 1, 29, and 32, slight shake in pellet.                                                                                                                                                                                                                                                                         | No alteration                                                                                                                                                                                                                    | No alteration                                                                                                                                                                                                                                                                 | Shake in pellet on side wires for suspending pellet not apparently injured.                                                                                                                                                                                                                                                                                                                                                                | —                                                                                                                                                                                                                                                                                  |
| Busters, iron, for 12-pounder segment shell.<br>Nos. 1 to 30 travelled in shell. | No defects                                                                                                                                                                                                                                                                                                                                                                  | No defects                                                                                                                                                                                                                       | No defects.                                                                                                                                                                                                                                                                   | —                                                                                                                                                                                                                                                                                                                                                                                                                                          | —                                                                                                                                                                                                                                                                                  |
| Tubes "friction," copper; 100 packed as for service.                             | No defects                                                                                                                                                                                                                                                                                                                                                                  | Six slightly damaged, slight portion of the composition shaken of 2 at top, and of 4 at the bottom.                                                                                                                              | Nine of these tubes are slightly defective, seven having a slight portion of the composition shaken out at top, and two a slight portion of the composition shaken out at the bottom.                                                                                         | Travelled with "Armstrong" ammunition.                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                    |
| Tubes "friction," copper; 90 packed as for service.                              | No defects                                                                                                                                                                                                                                                                                                                                                                  | No defects                                                                                                                                                                                                                       | One, slight portion of composition shaken out at top.                                                                                                                                                                                                                         | Travelled with "Whitworth" ammunition.                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                    |



## Report of Examination of 12-pounder Experimental Ammunition, &amp;c.—continued.

| Description of Stores.                                                                 | Examination<br>13th January 1865.                                                                                                                                                                                                                              | Examination<br>19th January 1865.                                                                                                                                                                                                                                                                                                                                                                                   | Examination<br>2nd February 1865.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Remarks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| "Armstrong," 12-pounder B.L., segment shell. From 1 to 15, packed as for service.      | Nos. 1, 2, 3, 6, 7, 10, 11, 13, 14, and 15, no apparent defects.<br>Nos. 5, 8, 9, 12, lead on body slightly scored and bruised by jolting in boxes.<br>*No. 4, lead at front end of base very much scored by head of screw for fixing packing pieces in boxes. | Nos. 10 and 14, no apparent defects.<br>Nos. 1, 3, 5, 6, 7, 9, and 13, lead on body slightly scored and bruised by jolting in boxes.<br>Nos. 2, 8, 11, and 15, lead on body considerably scored and bruised.<br>*Nos. 4 and 12, lead at front end of base very much scored by head of screw for fixing packing pieces.<br>†Several of the discs of wood for supporting bottom of shell in box loose, and one split. | Nos. 1, 3, 6, 7, 9, 10, 13, and 14, lead on body slightly scored and bruised by jolting.<br>No. 2, lead on body considerably scored by head of screw for fixing wood packing pieces; lead in burster chamber slightly bruised by burster while travelling.<br>*Nos. 4 and 12, lead on body very much cut and scored at top end of base by head of screw for fixing wood packing pieces.<br>No. 5, lead on body scored by plug of shell working out while travelling.<br>No. 8, lead on body considerably scored by screw head for fixing wood packing pieces, and by fuze key falling among shell while travelling.<br>Nos. 11 and 15, lead on body slightly scored by screw head, and lead in burster chamber slightly bruised by burster; one brass plug shaken out of shell in boxes while travelling. | *The same screw head injured both these shells.<br>No. 12 having been placed after the first examination in the compartment in which No. 4 had been travelled.<br>At the second examination the screw head projected about $\frac{1}{8}$ of an inch in the box; it was therefore removed.<br>The diameters at base end of shell are enlarged about .004 of an inch; this does not affect their passing into the chamber.<br>Nos. 1, 6, and 10 shell were fired at proof butt fm. No. — 10/2/65.<br><sup>53</sup><br>†These discs were all removed when the boxes were repaired after examination, 19/1/65. |
| "Armstrong," 12-pounder M.L., segment shell. No. from 1 to 15 packed as for service.   | Nos. 1, 2, 7, 8, 10, 11, 13, and 15 no apparent defects.<br>Nos. 3, 4, 5, 6, 9, 12, and 14, buttons slightly bruised.<br>1 brass plug shaken out of shell in boxes.<br>1 screw for fixing packing pieces in boxes, worked out.                                 | The buttons on the whole of the shell slightly bruised.<br>No. 9, lead in burster chamber slightly damaged by burster while travelling.<br>†Another screw from the same packing piece as that noticed on last examination worked out, the packing piece being now only held by one screw.                                                                                                                           | The buttons of the whole bruised, but there is no body.<br>§Nos. 1, 5, 7, 8, 9, 10, 12, 13, 14, 15, the lead in burster chamber is slightly bruised by burster while travelling.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ‡The bursters travelled in these shells were charged with powder.<br>Nos. 2, 3, and 6 shell were fired at proof butt fm., No. —, 10/2/65.<br>§The wood packing pieces were repaired and re-fixed after the examination, 19/1/65.                                                                                                                                                                                                                                                                                                                                                                           |
| "Whitworth," 12-pounder M.L., shrapnel shell. Nos. from 1 to 15 packed as for service. | No defects to any of the shell strings of 3 plugs cut.<br>2 brass plugs shaken out of shell in boxes.                                                                                                                                                          | No defects - - - -<br>No alteration                                                                                                                                                                                                                                                                                                                                                                                 | There is no apparent defect in the body of these shells. The strings of plugs in Nos. 12, 13, and 14 are cut.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Nos. 2, 5, and 13, shell fired at proof butt from No. —, 10/1/65.<br><sup>231</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Lubricators, "Whitworth," No. 15 packed as for service.                                | No defects - - - -                                                                                                                                                                                                                                             | No defects - - - -                                                                                                                                                                                                                                                                                                                                                                                                  | No defects.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | —                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

MEMO.—The lubricators for the Whitworth guns, which were screwed on a brass plate and carried horizontally in the liner box, were uninjured. Those for the B.L. Armstrong guns were found to be "dummies," on opening the cartridges in which they are choked, but the cartridges are uninjured.

N.B.—Staple for carrying laboratory knives in lid of box containing B.L. shell broken.

Several of the fuze implements in box containing "Whitworth" shell, were found shaken out of their places on each examination. The bradawls, fuze-key, and drift, being generally out.

RICH. K. FREETH, Major R.A.  
Inspector of Ordnance.

SIR,

24th February 1865.

I HAVE the honour to inform the Armstrong and Whitworth Committee that I have carefully considered the question of the possibility of the ammunition referred to in your letter of the 20th December 1864, suffering deterioration by being kept in store for a long time in different climates, and I have to submit to the Committee the following observations with regard to the individual shells and fuzes included in the ammunition:—

1. There can be no question as to the permanent characters of the Armstrong M.L. shell and the Whitworth shell; the only precaution to be attended to in their preservation, in any climate, being the renewal of the lacquer as soon as it no longer effectively protects the external surfaces of the metal from rust.

2. I am also of opinion that the Armstrong B.L. shell, as now manufactured, will not be found susceptible of deterioration. The liability of the soft metal coating to separate from the body of the shell, in consequence of different effects of heat upon the two metals, and of the non-elastic nature of the soft metal, has been entirely overcome by soldering the metals together, through the agency of zinc. Instances have occurred in which a separation of the metals, in a few very small places, has been observed some time after the projectiles had been in store, a result which was traced to the accidental enclosure of minute quantities of saline matter between the metals, whereby a voltaic action was established. I believe that the possibility of this occasional trifling separation has been set aside in the manufacture of the projectiles in question; but even where it has occurred it has never been detrimental to the efficiency of the ammunition.

The superficial oxidation which the soft metal undergoes within a short period after the completion of the projectiles, affords the best possible protection against continued atmospheric action; it is only further essential to their proper preservation to protect the exposed iron portions by means of lacquer, and to extend the coating of the latter on to the soft metal to such an extent as to ensure the covering of the exposed points of juncture between the two metals.

3. The Armstrong time and percussion fuze, or, more strictly, that part which constitutes the time fuze, is unquestionably more susceptible of deterioration than any of the other descriptions of ammunition enumerated in your letter of the 20th December 1864. The fuze composition, though protected by means of a coating of paper and by the leather washer which is fixed into the cap, is still sufficiently accessible to moisture to render it very liable to serious deterioration by a protracted preservation of these fuzes in damp localities. The priming contained in the annular recess just below the nut, and also the priming pellet in the cap, are still more open to injury from damp than the fuze composition. After the exposure of a fuze of this description for one month to a moist atmosphere, the temperature of which ranged from 90° to 120° Fah., the priming compositions were found to have become so much injured as to burn with very great difficulty.

Another portion of this fuze which is likely to become injured by time, although it is excluded from the effects of atmospheric moisture, by enclosure within the body of the fuze, is the iron pin which serves to ignite the

detonator. The small quantity of priming which is fixed round the base of that pin, and in actual contact with it, cannot fail to corrode the iron, an oxidising action being established by the small quantity of moisture present originally and unavoidably in the composition. The pin of the fuze examined by me was much rusted, and the rust had penetrated to a considerable extent into the composition, interfering with its inflammability. Judging from the appearance of the pin and of the slight force requisite to break it (the thickness of the metal having been much reduced by corrosion), I consider it likely that these pins will frequently be corroded to such an extent as at any rate to destroy their points, and to deprive them of the power of perforating the detonators.

It is evident that these particular fuzes must be preserved in store in perfectly water-proof cases, but even this precaution will not prevent the deterioration of the igniting arrangement, consequent upon the contact of the iron pin with priming composition.\*

4. The construction of the Armstrong pillar fuze is, in my opinion perfectly calculated to ensure its permanent efficiency under all climatic conditions.

5. Boxer's wood fuze is naturally susceptible of alteration in its external dimensions, from the swelling or shrinking of the wood in very damp, or dry and warm situations. In one month's exposure of one of these fuzes to a warm moist atmosphere, the wood had swollen sufficiently to loosen the paper which bears the numbers, and is fastened over the holes provided for setting the fuze. This loosening, and possible detachment, of the index is the only inconvenience likely to result from the effects of climate upon the fuze, and may be overcome without difficulty. By the paper lining in the fuze, any slight changes which the wooden case may undergo for a time in its dimensions, are prevented from interfering with the efficiency of the fuze. The priming contained in the small perforations, and in the end of the fuze, appears to me to require more permanently efficient protection from the effects of moisture than that afforded by the thin painted paper coverings, which, as I have pointed out, are liable to become loosened. This could obviously also be accomplished readily; and I am of opinion that there would then be no part vital to the efficiency of this fuze, likely to suffer deterioration.

6. I consider that Boxer's metal fuzes are as little susceptible of deterioration by being kept in store in different climates, as Armstrong's pillar fuze. I have only to observe, with reference to them, that the small piece of paper or gut-skin, coated with shellac, which is fixed upon the perforation at the bottom of the fuze, cannot be nearly so efficient in permanently excluding moisture from having access to the interior of the fuze, as the thin plates of metal, employed for closing the perforations in the bases of the Armstrong fuzes referred to above.

In the foregoing observations I have included all points which appear to me possibly susceptible of interfering with the permanent efficiency of the ammunition received from the Committee.

The Secretary,  
Armstrong and Whitworth  
Committee.

I have, &c.  
F. A. ABEL,  
Chemist of the War  
Department.

\* These remarks refer equally to the time fuze when apart from the percussion fuze, but do not bear any reference to the latter, which does not appear to be in any way liable to deterioration.—F. A. A.



REPORT OF EXAMINATION OF EXPERIMENTAL FUZES, LUBRICATORS, 70-POUNDER SHELLS, &c., travelled for Twenty Days in a Flanders Wagon, by Principal Superintendent of Stores, for Armstrong and Whitworth Committee, and Examination after every Four Days by Inspector of Ordnance.

| Description of Stores.      | How packed.                                                                                                                                 | Examination.<br>13th October 1864.                                                                                                                                                                                                                                                                                   | Examination.<br>20th October 1864.                                                                                                                                                                                                                                                                | Examination.<br>27th October 1864.                                                                                                        | Examination.<br>3rd November 1864.                                                                                                                                              | Examination.<br>10th November 1864.                                                                                                                                                                                                                                                               | Examination, 13th February 1865, after opening defective Fuzes, &c.                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Remarks.                                                                                                         |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
|                             |                                                                                                                                             |                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                   |                                                                                                                                           |                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                  |
| Fuzes, time, Armstrong.     | As for service; in water-proof paper bags and tin boxes.<br>Travelled "top up," Nos. 1 to 10.<br>Travelled "bottom up," Nos. from 11 to 20. | Nos. 1, 3, 7, and 10, no apparent defects.<br>Nos. 2, 5, 6, and 8, slight in pellet "on end."<br>Nos. 4 and 9, slight shake in pellet "on side."<br>Nos. 13, 14, and 20, no apparent defects.<br>Nos. 11, 15, 16, and 17, slight shake in pellet "on end."<br>Nos. 12, 18, and 19, slight shake in pellet "on side." | No alteration                                                                                                                                                                                                                                                                                     | No alteration                                                                                                                             | No alteration                                                                                                                                                                   | No alteration from examination 13th October.                                                                                                                                                                                                                                                      | On examination of these fuzes after opening the slight shake in pellet noticed in a portion of them on the first examination was found to be owing to the manufacture, and not from any defect caused by travelling; it being caused by a slight amount of play between the pellet and the body of the fuze, but the needles were all found to be very much corroded and in one case (No. 6) entirely destroyed. This has probably been caused by a small portion of composition which is pressed round the needle. | The whole of these fuzes were packed in a deal box, and travelled in the wagon as marked in column "How packed." |
| Fuzes, time, "Boxer."       | In zinc boxes<br>Travelled "bottom up," Nos. from 1 to 10.<br>Travelled "top up," Nos. from 11 to 20.                                       | Nos. 2, 3, 5, 6, 8, and 10, no apparent defects.<br>Nos. 1, 4, 7, and 9, slight shake in pellet "on side."<br>Nos. 11, 12, 14, 15, 16, 17, 18, and 19, no apparent defects.<br>Nos. 13 and 20, slight shake in pellet "on side."                                                                                     | No alteration                                                                                                                                                                                                                                                                                     | No alteration                                                                                                                             | No alteration                                                                                                                                                                   | No alteration from examination 13th October.                                                                                                                                                                                                                                                      | The shake in the pellets of these fuzes when opened was found to be but slight, and principally on the side, Nos. 4, 13, and 20 were found to have a slight amount of end shake, and on removing the wires they were found slightly sheared or compressed, but not to an extent to render them unsafe.                                                                                                                                                                                                              |                                                                                                                  |
| Fuzes, percussion, "Boxer." | Wrapped in brown paper.<br>Travelled "top up," Nos. from 1 to 10.<br>Travelled "bottom up," Nos. from 11 to 20.                             | No apparent defects<br>No apparent defects<br>No apparent defects                                                                                                                                                                                                                                                    | Nos. 1, 2, 3, 4, 5, 6, 7, 9, and 10, no apparent defects.<br>No. 8, slight shake in pellet "on side."<br>Nos. 11, 13, 16, 17, and 20, no apparent defects.<br>Nos. 12, 14, 15, 18, and 19, slight shake in pellet "on side."                                                                      | Nos. 1, 3, 4, 5, 6, 7, and 9, no apparent defects.<br>Nos. 2 and 8, slight shake in pellet "on side."<br>No alteration                    | No alteration<br>No alteration                                                                                                                                                  | No alteration from examination 27th October.<br>No alteration from examination 27th October.                                                                                                                                                                                                      | The shake in the pellets of these fuzes was found to be but very slight and principally on the side; this is due to manufacture. In one fuze (No. 19) there was a slight amount of end shake, and on removing the wire for suspending the pellet it was found to be very slightly compressed, but not to an extent to render the fuze at all unsafe.                                                                                                                                                                |                                                                                                                  |
| Fuzes, pillar, "Armstrong." | Travelled "top up."<br>Travelled "bottom up."                                                                                               | Nos. 1, 2, 3, 4, 5, 6, and 7, no apparent defects.<br>Nos. 8, 9, and 10, slight shake in guard.<br>Nos. 11, 12, 14, 15, 18, and 20, no apparent defects.<br>Nos. 13, 15, 17, and 19, slight shake in guard.                                                                                                          | Nos. 1, 2, 3, 5, 6, and 7, no apparent defects.<br>Nos. 8 and 9, shake in guard considerably increased.<br>Nos. 4 and 10, slight shake in guard.<br>Nos. 11, 12, 14, and 18, no apparent defects.<br>Nos. 13, 15, 16, and 20, slight shake in guard.<br>Nos. 17 and 19, shake in guard increased. | No alteration<br>Nos. 8 and 9, defect slightly increased.<br>No alteration<br>No alteration<br>No alteration<br>Shake slightly increased. | No alteration<br>Nos. 4, 8, and 9, defect slightly increased.<br>No. 10, slight shake in guard.<br>No alteration<br>No alteration<br>No alteration<br>Shake slightly increased. | Nos. 1, 2, 5, 6, and 7, no apparent defects.<br>Nos. 4, 8, and 9, guards apparently partially sheared.<br>Nos. 3 and 10, slight shake in guard.<br>No alteration from examination 20th October.<br>No alteration from examination 20th October.<br>Shake in guard, and pillar slightly increased. | On examination of these fuzes after being cut open, a considerable amount of damage was found to have taken place, especially in those travelled "top up," Nos. 4, 8, and 9, the feathers in guard are entirely sheared.<br>Nos. 3 and 10, the feathers in guard are slightly compressed, but the regulators are not damaged in either of the above.<br>Nos. 13, 15, and 20, feathers in guard slightly compressed.<br>Nos. 16, 17, and 19, feathers in guard and regulator slightly compressed.                    |                                                                                                                  |

Report of Examination of Experimental Fuzes, Lubricators, 70-pr. Shells, &c.—*continued*.

| Description of Stores.                                   | How packed.                                                                                                                                                                                                                              | Examination, 13th October 1864.                                        | Examination, 20th October 1864.                                                                                                                                          | Examination, 27th October 1864.                                                                                                                                              | Examination, 3rd November 1864.                                                                               | Examination, 10th November 1864.                                                                                                                                                                                                                                                  | Examination, 13th February 1865, after opening defective Fuzes, &c. | Remarks. |
|----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|----------|
| Lubricators, "Armstrong," Nos. 1 to 24.                  | As for service, (viz.) in a deal box 26" long, 16" wide, and 12" deep. The lubricators being packed in 4 tins of 6 each, with a wood batten between each tin; the first and third tin being "top up," the second and fourth "bottom up." | No apparent defects                                                    | Nos. 5, 10, 19, and 20, copper cracked on upper part, oil escaping. No. 7, copper cracked in under side, oil escaping. The above were removed from the box at this date. | Nos. 6, 8, 9, 15, and 24, copper cracked on upper part, oil escaping. No. 18, copper cracked in under side, oil escaping. These were also removed from the box at this date. | Nos. 2, 11, 13, 17, 22, and 23, copper cracked on upper part, oil escaping. These were removed at this date.  | Nos. 4 and 14, copper cracked on upper part, oil escaping. Nos. 1, 3, 12, 16, and 21, not apparently injured.                                                                                                                                                                     |                                                                     |          |
| Lubricators, "Whitworth," Nos. 1 to 26.                  | As for service, (viz.) in a deal box, 25" long, 17" wide, and 12" deep. The lubricators being packed in 3 rows of 8, on their edge, and the box filled with brown paper.                                                                 | No apparent defects                                                    | No. 26, one of the wires for fixing the thin wad broken.                                                                                                                 | No. 2, both wires for fixing the thin wad broken.                                                                                                                            | No alteration                                                                                                 | Nos. 2 and 26, both wires for fixing thin wad broken. Nos. 16 and 17, one wire for fixing thick wad broken.                                                                                                                                                                       |                                                                     |          |
| Shell, segment, 70-pr. B.L. Nos. 1 to 10.                | Loose in wagon                                                                                                                                                                                                                           | Lead very much bruised, but diameters all within limits.               | Nos. 1, 4, 6, 7, 9, and 10, lead at base much bruised. No. 7, a small portion of the lead off body; shells generally full to gauge.                                      | Nos. 1, 4, 5, 6, 7, and 10, high gauge will not pass over the base or body. Nos. 6, 7, and 10, a small portion of lead off the body.                                         | Nos. 4, 6, 7, and 9, high gauge will not pass over the body or base; No. 7 about 1½ in. of lead off the body. | Nos. 6 and 8, the high gauge will not pass over the body or base. No. 7, about 3¼ x 2 inches of lead off the body, and very much burred over at base. The lead on the whole of the shells is very much bruised, but in no case to an extent to prevent them passing into the gun. |                                                                     |          |
| Shells, segment, 70-pr. muzzle-loading, Nos. 1 to 10.    | Loose in wagon                                                                                                                                                                                                                           | Studs of all the shells very much bruised.                             | Studs of all the shells very much bruised.                                                                                                                               | Nos. 2, 6, and 9, studs very much bruised, being increased in width about .1 of an inch.                                                                                     | Shells and studs in about the same condition as on last examination.                                          | Nos. 1, 2, 3, 4, 6, 8, 9, and 10, some of the studs on these shells are bruised to an extent that it is doubtful whether they will pass into the narrow shunt at the bottom of the bore. In other respects the shell does not appear to be injured.                               |                                                                     |          |
| Shells, shrapnel, "Whitworth," 70-pounder, Nos. 1 to 10. | Loose in wagon                                                                                                                                                                                                                           | Strings of brass plugs partially destroyed. Body of shell not injured. | Strings of plugs nearly all destroyed. Body of shell not injured.                                                                                                        | Strings of plugs all destroyed. Body of shells not injured.                                                                                                                  | No alteration                                                                                                 | No alteration.                                                                                                                                                                                                                                                                    |                                                                     |          |

RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.



## No. 55, E.O.C. 70-pr. ARMSTRONG WEDGE BREECH-LOADING RIFLE GUN.

This gun is in precisely the same state both as regards dimensions and defects as when received from Elswick, viz.:-

Bore slightly dented at 74" from D. to R. of up, and slight tool marks in powder chamber at 2 R. of up to L. of up, and 14½ R. of D. to D.

## No. 59, E.O.C. 70-pr. ARMSTRONG MUZZLE-LOADING SHUNT RIFLE GUN.

Developed during recent firing. { Slight flaw or defect in steel in bore, commencing at 21½" from bottom of bore of R. of up, and extending to 22¼ L. of D., at which point it extends all round the bore.

The bore is also grazed by the shot from 47 to 95 inches from muzzle nearly all round; this was done at proof, and has not increased since.

## No. 268, 70-pr. WHITWORTH MUZZLE-LOADING RIFLE GUN.

Developed during the recent firing. { Slight fissures and scoring from front of copper bouche extending to about 10 inches from front of vent in the groove in line of the vent and the one on the right, and on the flat or lands on loading side. There is also a slight wearing of the copper and slight fissuring of the bore at the edge of the bouche in rear of vent.

The bore is also dented from 18 to 21½ from bottom of bore "D.;" this was done at proof, and has not increased during the late firing.

23/6/64.

RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

REPORT of EXAMINATION of 12-pr. and 70-pr. Armstrong and Whitworth Rifle Guns, for Armstrong and Whitworth Committee at Shoeburyness, from 4th to 9th July 1864.

## No. 55A, 70-pr. ARMSTRONG BREECH-LOADING RIFLE GUN.

*Examination before firing the 120 rounds of rapid firing.*—Slight scoring at junction of powder and shot chamber extending from right to up to left. Bottom of vent considerably worn on the left side, the dimensions being .53 by .23 of an inch; the cone of the copper bouche was also worn, and a piece of thin steel could be passed up between the gun and the cone about .6 of an inch.

Shot chamber expanded at front end .002 of an inch.

Bore expanded at front of shot chamber .005 of an inch.

This gun was re-bouched before firing the 120 rounds.

*Examination after firing 120 rounds rapid firing.*—Scoring at junction of powder and shot chamber not increased.

Bottom of vent cut away by gas in rear, the defects extending about .7 of an inch up the vent and taking a spiral form. Expansion in shot chamber and bore not increased.

Recess for nose of stopper { Horizontally, .01 of an inch.  
expanded. { Vertically, nil.

## No. 59A, 70-pr. ARMSTRONG MUZZLE-LOADING SHUNT RIFLE GUN.

*Examination before firing 120 rounds of rapid firing.*—Bore expanded from 9 to 18 inches from bottom .002 of an inch.

The slight flaw in bore from 21 to 22¼ inch from bottom has not increased. Slight fissures in front of vent about .1 of an inch long, and copper slightly worn round edge of cone. Diameter of vent .23 full.

*Examination after firing 120 rounds of rapid firing.*—Expansion in bore not increased.

Slight flaw from 21 to 22¼ inches from bottom not increased.

Fissures in front of vent increased to .25 long, and wearing round edge of cone slightly increased. Diameter of vent increased to .24 full.

## No. 268A, 70-pr. WHITWORTH MUZZLE-LOADING RIFLE GUN.

*Examination before firing 120 rounds of rapid firing.*—Fissures and scoring in front of vent considerably increased in length, breadth, and depth, it now extending to 12 inches in front of vent and from "right of up to left of up;" there are also several slight fissures in rear of the vent about .15 of an inch long. The denting in the bore from 18" to 21¼" down has not increased, but there is a slight amount of wearing on the bearing side of angle.

This gun was re-bouched prior to this examination.

*Examination after firing 120 rounds of rapid firing.*—The fissuring and scoring in bore very much increased in

length and depth, it now extending to 16 inches in front of vent, and to .45" in rear.

Bore enlarged in angles in front of vent by scoring; amount of enlargement at 8½ inches from bottom .006 of an inch tapering off to .001 at 17 inches.

The bore is also enlarged at 6 inches from the bottom .001, and at the bottom of the bore .004 of an inch.

The bottom of the vent is very much enlarged, and there is also a considerable opening all round the cone of the copper bouche.

The diameter of the vent is .23 full.

The denting in bore and wear in angles has not increased. There is no alteration in these guns, the examination will therefore be the same as reported 21st June 1864.

Gutta percha impressions of the defects in the above guns, and of the vents of 70-pr. 267B Whitworth and No. 60B. shunt guns were left at Shoeburyness for the inspection of the Committee.

RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

## No. 58, 70-pr. E.O.C. MUZZLE-LOADING SHUNT RIFLE GUN.

Proved at Elswick, 21st May 1863.

Received from Elswick, 8th January 1864.

Proved at Woolwich, 22nd February 1864.

## No. 59, 70-pr. E.O.C. MUZZLE-LOADING SHUNT RIFLE GUN.

Proved at Elswick, 29th May 1863.

Received from Elswick, 9th January 1864, without further proof.

## No. 60, 70-pr. E.O.C. MUZZLE-LOADING SHUNT RIFLE GUN.

Proved at Elswick, 19th June 1863.

" " 9th July "

" " 17th " "

Received from Elswick, 9th January 1864, without further proof.

## No. 49, 70-pr. E.O.C. WEDGE BREECH-LOADING GUN.

Proved at Elswick, 11th March 1863.

Received from Elswick, 8th January 1864, without further proof.

## No. 55, 70-pr. E.O.C. WEDGE BREECH-LOADING GUN.

Proved at Elswick, 5th June 1863.

Received from Elswick, 9th January 1864, without further proof.

## No. 56, 70-pr. E.O.C. WEDGE BREECH-LOADING GUN.

Proved at Elswick, 17th June, 1863.

Received from Elswick, 9th January 1864, without further proof.

## No. 267, 70-pr. MUZZLE-LOADING WHITWORTH GUN.

Received from Mr. Whitworth, 18/3/64.

Proved at Woolwich, 23/3/64.

## No. 268, 70-pr. MUZZLE-LOADING WHITWORTH GUN.

Received from Mr. Whitworth, 18/3/64.

Proved at Woolwich, 22/3/64.

## No. 276, 70-pr. MUZZLE-LOADING WHITWORTH GUN.

Received from Mr. Whitworth, 23/3/64.

Proved at Woolwich, 24/3/64.

RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

REPORT of EXAMINATION of Three 70-pr. Experimental Rifle Guns for Armstrong and Whitworth Committee at Shoeburyness, 21st July 1864.

## No. 59A, E.O.C. ARMSTRONG MUZZLE-LOADING SHUNT RIFLE.

Slight fissures in front of vent increased to .3 of an inch in length, and wearing round cone of copper bouche slightly increased. In other respects the gun is in the same condition as reported 6th July 1864.

This gun has been re-vented since this examination.

## No. 55A, E.O.C., ARMSTRONG BREECH-LOADING RIFLE GUN (WEDGE).

No alteration. Examination as reported 6th July 1864.

## No. 268A, WHITWORTH MUZZLE-LOADING RIFLE GUN.

Fissures and scoring slightly increased in length and depth. The impressions when first removed from the gun showed the gutta percha to have been forced upwards of .1 of an inch into the fissures both in front and rear of the cone of the vent. There has evidently been an alteration made in this gun since the last examination. The groove

in line of the vent has apparently been either filed or scraped for 7 or 8 inches in front of the vent, by which means a portion of the scoring has been removed, as shown on the impressions; the groove also is enlarged at that part, the amount of enlargement being as follows:—

|                                    |                 |
|------------------------------------|-----------------|
| At 9 in. from bottom of bore -     | ·01 of an inch. |
| 12       "       "       "       " | ·007       "    |
| 15       "       "       "       " | ·005       "    |
| 17       "       "       "       " | ·002       "    |

In other respects the examination is the same as reported 6th July 1864.

This gun has been re-vented prior to this examination.

RICH. K. FREETH, Major, R.A.,  
Inspector of Ordnance.

REPORT of EXAMINATION of 70-pr. and 12-pr. Armstrong and Whitworth Competitive Rifle Guns at Shoeburyness for Armstrong and Whitworth Committee, 16th, 17th, and 19th September 1864.

70-pr., No. 268, WHITWORTH MUZZLE-LOADING RIFLE GUN.

The fissures and scoring in bore have considerably increased since examination 21/7/64, both in length and depth, they now extending from 2 inches in rear to 19 inches in front of copper bouche.

The diameter of bore in the groove in line of old vent has also slightly increased, the enlargement being as follows:—

| Enlargement since last Examination.     | Total Enlargement. |
|-----------------------------------------|--------------------|
| At 9 in. from bottom of bore Nil.       | ·016               |
| 12       "       "       "       " Nil. | ·011               |
| 15       "       "       "       " ·002 | ·008               |
| 17       "       "       "       " ·003 | ·006               |

The bore is also slightly expanded, the amount of expansion since last examination and total amount being as follows:—

| Expansion since last Examination, 21/7/64. | Total Expansion. |
|--------------------------------------------|------------------|
| At bottom of bore - - ·003                 | ·007             |
| 3 in. from bottom of bore ·003             | ·006             |
| 6       "       "       "       " ·003     | ·004             |
| 9       "       "       "       " ·003     | ·003             |
| 12       "       "       "       " ·002    | ·002             |
| 15       "       "       "       " ·004    | ·004             |
| 18       "       "       "       " ·009    | ·009             |
| 21       "       "       "       " ·004    | ·004             |
| 24       "       "       "       " ·002    | ·002             |

The wearing on bearing side of groove also appears to be slightly increased.

Copper plug inserted in old vent projects into bore ·3 of an inch.

Vent in centre of bottom, no defects.

70-pr., No. 59, E.O.C. MUZZLE-LOADING SHUNT RIFLE GUN.

Slight fissures or crack in bore, extending from 3·9 to 4·5 inches from bottom of bore "Left of up."

Fissure in front of vent increased to ·6 of an inch in length, and wearing round cone of vent slightly increased.

The driving edge of the grooves are all slightly worn; the wear on the two upper grooves appear only to be about half the depth of the groove, while the lower one is worn the whole depth. The greatest amount of wear is in the groove "Left of up," where it shows on the impression to be about 0·5 of an inch, and to extend from 2½ to 21½ inches from end of rifling; the wear in the other two is about ·03 of an inch.

The defect in bore from 21½ to 22½ has not increased.

No expansion in the bore has taken place since last examination, 21/7/64.

The whole of the expansion which has taken place since the commencement of the experiment is ·002 of an inch in the powder chamber.

70-pr., No. 55, E.O.C. BREECH-LOADING WEDGE GUN.

Slight defect in powder chamber "Right," a piece of steel having been let in; this had slightly started. This defect extends about 1 by 1½ inches from end of powder

chamber. Scoring at junction of powder and shot chamber on the upper part of the bore slightly increased.

No expansion in the bore or chamber has taken place since last examination, 21/7/64.

Slight defect in nose of stopper, a piece of steel having been let in; both this and the piece in the powder chamber have been let in since the examination, 21/7/64.

The expansion in the bore and chamber since commencement of firing is as follows:—

| Expansion since Commencement of Experiment. |                                         | Expansion since last Examination, 21/7/64. |
|---------------------------------------------|-----------------------------------------|--------------------------------------------|
| Powder chamber.                             | At 1½" from breech end ·002             | Nil.                                       |
|                                             | 9½       "       "       "       " ·001 | "                                          |
|                                             | 13       "       "       "       " ·001 | "                                          |
| Shot chamber.                               | Breech end - ·003                       | "                                          |
|                                             | Muzzle end - ·003                       | "                                          |
| Bore                                        | At 25½ - - ·003                         | "                                          |
|                                             | 28       "       "       "       " ·006 | "                                          |
|                                             | 32       "       "       "       " ·010 | "                                          |
| Recess for stopper.                         | Horizontal - ·010                       | "                                          |
|                                             | Vertical - ·001                         | "                                          |
| Nose of stopper.                            | Horizontal - ·010                       | "                                          |
|                                             | Vertical - Nil.                         | "                                          |

C. M. MOLONY, Lieutenant, R.A.,  
For Inspector of Ordnance.

REPORT of EXAMINATION of Three 70-pr. Rifle Guns for Armstrong and Whitworth Committee at Shoeburyness, 22nd October 1864.

No. 268, 70-pr. WHITWORTH MUZZLE-LOADING RIFLE GUN.

Fissures and scoring in bore slightly increased in depth and length, it now extending to 3½ inches rear and 19½ inches in front of vent from edge of cone.

The impression taken while the copper bouche was out of the gun shows the fissures in front and rear of cone to be about ·25 of an inch in depth.

Slight graze in bore from 22½ to 23½ from bottom of bore "R. of up."

This gun had been re-vented in end of bore prior to this examination, and the copper cup has also apparently been replaced with a new one.

In other respects the gun is in the same condition as reported 16th Sept. 1864.

No. 59, E.O.C. 70-pr. MUZZLE-LOADING SHUNT RIFLE GUN.

Slight fissures or crack from 3·9 to 4·5 inches from bottom "L. of up" not increased.

Fissure in front of vent increased in length to ·75 of an inch.

Wear on driving side of grooves not increased.

Diameter of vent through ·24 of an inch.

In other respects the gun is in the same condition as reported 16th Sept. 1864.

No. 55, E.O.C. 70-pr. BREECH-LOADING WEDGE GUN.

Slight defect in end of powder chamber removed by a ring 2 inches broad having been inserted in end of chamber.

No apparent increase of scoring at junction of powder and shot chamber.

Diameter of vent through ·23, but the ·25 gauge will pass down about 2 inches diameter at bottom ·45.

In other respects the gun is in the same condition as reported 16th Sept. 1864.

RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

REPORT of EXAMINATION of Three 70-pr. Experimental Rifle Guns for Armstrong and Whitworth Committee at Shoeburyness, 4th November 1864.

70-pr., No. 268, WHITWORTH MUZZLE-LOADING RIFLE GUN.

Fissures and scoring in bore not increased since last examination.

Copper cup in end of bore apparently crushed back; this defect commences at 1½ inch from centre of vent and extends to exterior edge of cup all round, the amount of displacement being about ·05 of an inch since last examination. The end of vent bouche is forced back about ·075 of an inch, and the diameter of the vent through the platina is increased about ·035 of an inch; there is also a slight opening between the edge of the cup and the bore; this is most apparent in the angles.



There is also a slight amount of expansion in the bore, the amount since last examination being as follows:—

|                                 |                  |
|---------------------------------|------------------|
| At 2 inches from bottom of bore | ·002 of an inch. |
| 6                               | ·002             |
| 12                              | ·001             |
| 17                              | ·002             |
| 20                              | ·016             |
| 21                              | ·011             |
| 22                              | ·010             |
| 23                              | ·007             |
| 24                              | ·005             |
| 25                              | ·002             |
| 26                              | ·001             |
| 30                              | Nil              |

70-pr., No. 55, E.O.C. BREECH-LOADING WEDGE GUN.

Slight expansion in recess for stopper, the amount being horizontal ·001, and vertical ·002 of an inch.

Diameter of vent ·23 full, bottom ·55 of an inch.

In other respects the gun is in the same condition as reported 17th Sept. 1864.

70-pr., No. 59, E.O.C. MUZZLE-LOADING SHUNT RIFLE GUN.

Fissures in front of vent and slight crack from 3·9 to 4·5 inches from bottom "L. of up" not increased; wearing round edge of cone slightly increased.

Wear on driving edge of groove not increased.

Diameter of vent through ·25 full, bottom ·55 of an inch.

In other respects the gun is in the same condition as reported 17th Sept. 1864.

10/11/61.

RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.

REPORT of EXAMINATION of Six 70-pr. Rifle Guns for Armstrong and Whitworth Committee at Shoe-buryness, 8th to 14th December 1864.

No. 55A, E.O.C. 70-pr. BREECH-LOADING WEDGE RIFLE GUN.

Slight defect in iron ring in end of P. C. up, apparently caused by the escape of gas. The diameter of the vent is ·24. In other respects the gun is in the same state as reported, 4/11/64.

No. 59A, E.O.C. 70-pr. MUZZLE-LOADING SHUNT RIFLE GUN.

The fissure in front of vent has increased ·1 of an inch. The bore is dented on edge of groove from 19·5 to 24 in. L. of D. ·013 deep. Diameter of vent, true. This gun has been re-vented since examination dated 4th November 1864.

No. 268A, WHITWORTH MUZZLE-LOADING RIFLE (70-pr.) GUN.

Copper cup in end of bore crushed back ·1 of an inch at 1·75" from centre. The end of vent bouche also forced back ·15 of an inch. The diameter of the vent has increased at ·7" from centre of vent. A hole ·3" deep and ·2" wide is found since last examination.

The fissures and scoring in the bore has not increased since reported 4/11/64.

No. 49B, E.O.C. 70-pr. BREECH-LOADING WEDGE RIFLE GUN.

Slight flaw in bore at 2½ R. of D., 46½ L. of D. and up, 50½ L. of up and R., 60½ and 69½ L. of D., not altered since receipt from Elswick. Slight flaw at 69 L. of D., 76½ D., and in P. C. 2½ L. of D., 4 Left at 4½ L. of up, from edge of copper bouche 1·45" long, 5 R. of D. and L. of D., 7 L. of up, 10½ R. and R. of up, 13½ L. of D. Slight scoring at junction of powder and shot chambers extending from R. to up to Lt.

Slight opening round cone of vent in powder chamber.

Diameter of vent "full" bottom ·4 of an inch. Powder chamber expanded ·002, and bore expanded in front of shot chamber ·003 of an inch.

No. 60B, E.O.C. 70-pr. MUZZLE-LOADING SHUNT RIFLE GUN.

Slight opening round cone of vent in bore. Diameter of vent ·23, bottom ·5 (the hole in vent has taken a spiral form). No expansion has taken place in the bore, but from the breech end to 36 ins. D. is scaly from rust caused by water in the bore; and on the upper surface about the same length is roughness, probably from the same cause.

No. 267B, WHITWORTH (70-pr.) MUZZLE-LOADING RIFLE GUN.

This gun has been vented through the end of breech, and original vent plugged up with copper.

The bore is slightly fissured by gas from front edge of plug to 2"; in other respects this gun is the same as at first examination.

20/12/64.

RICH. K. FREETH, Major R.A.,  
Inspector of Ordnance.





# **12-PR. GUNS.**

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**EXPERIMENTS** carried out by the **SPECIAL ARMSTRONG**  
and **WHITWORTH COMMITTEE.**





# 12-POUNDER BREECH-LOADING ARMSTRONG GUN.

## EXPERIMENTS FOR DETERMINING RANGE AND ACCURACY.

N.B.—The figures in *Italics* are the rounds struck out by the competitors as abnormal shots.

### SOLID SHOT.

SHOEBURYNNESS.

#### Particulars, &c. of Gun No. 38.

Weight, 8 cwt. 2 qrs.  
Length, 6 ft. 10·95 in.  
Diameter of bore, 3 in.  
Length of bore, 6 ft. 1·42 in.  
Grooves { No. 38.  
          { Width, ·15 in.  
          { Depth, ·05 in.  
Spiral, 1 turn in 38 calibres.

#### Particulars, &c. of Shot and Ammunition.

Weight, 11 lbs. 9 oz.  
Diameter, 3·074 inches.  
Length, 7·01 in.  
Length of cartridge, 8·25 inches, lubricator included.  
Diameter of cartridge, 3 inches.  
Brand of powder, A4.  
Charge, 1½ lbs.  
Wad, service lubricator ; no sponging.

| No. of Round. | Elevation. | Range. | Recoil. | 1st Graze. |        | 2nd Graze. |        | 3rd Graze. |        | Remarks.                                  |
|---------------|------------|--------|---------|------------|--------|------------|--------|------------|--------|-------------------------------------------|
|               |            |        |         | Right.     | Left.  | Range.     | Right. | Range.     | Right. |                                           |
|               | °          | Yards. | Ft. in. | Yards.     | Yards. | Yards.     | Yards. | Yards.     | Yards. | <i>April 4, 1864.</i>                     |
| 1             | 0          | 490    | 4 6     | 5·2        | —      | 2,196      | 6·4    | 3,900      | 188    | The gun was placed 15 feet right of line. |
| 2             | "          | 496    | 5 6     | 5·6        | —      | 2,376      | 40     | 3,561      | 96     |                                           |
| 3             | "          | 521    | 5 8     | 4·2        | —      | 2,146      | 30     | 3,500      | 70     |                                           |
| 4             | "          | 502    | 5 6     | 5·2        | —      | 2,006      | 24·4   | 3,250      | 232    | Weather :—Hazy at 10 a.m.                 |
| 5             | "          | 519    | 5 6     | 5·4        | —      | 1,959      | 22·6   | 3,340      | 139    | Slight haze at 3 p.m.                     |
| 6             | "          | 492    | 5 9     | 5·0        | —      | 2,118      | 25·0   | 3,365      | 79     | Wind :—Direction, S.E. by E.; force, 1;   |
| 7             | "          | 484    | —       | 4·2        | —      | 2,106      | 23     | 3,416      | 166    | 10 a.m.                                   |
| 8             | 1          | 856    | 5 11    | 5·4        | —      | 2,422      | 54     | 3,520      | 124    | " N.N.W.; force, 1;                       |
| 9             | "          | 866    | 5 6     | 4·8        | —      | 2,470      | 52     | 3,723      | 172    | 3 p.m.                                    |
| 10            | "          | 878    | 5 9     | 7·8        | —      | 2,555      | 56     | 3,520      | 163    | Thermometer :—48 dry, 47 wet, 10 a.m.     |
| 11            | "          | 878    | 5 7     | 6·0        | —      | 2,506      | 64     | 3,725      | 244    | 60 " 58 " 3 p.m.                          |
| 12            | "          | 858    | 5 9     | 6·2        | —      | 2,466      | 56     | 3,580      | 130    | Barometer :—29·75 50 10 a.m.              |
| 13            | "          | 799    | —       | 6·4        | —      | 2,474      | 48     | 3,470      | 200    | Reading. Temperature.<br>29·95 62 3 p.m.  |

| No. of Round. | Elevation. | Range. | 1st Graze. |        |        | 2nd Graze. |        | Remarks.                                                                     |
|---------------|------------|--------|------------|--------|--------|------------|--------|------------------------------------------------------------------------------|
|               |            |        | In Line.   | Right. | Left.  | Range.     | Right. |                                                                              |
|               | °          | Yards. |            | Yards. | Yards. | Yards.     | Yards. | <i>May 13, 1864.</i>                                                         |
| 1             | 0          | 473    | —          | 5·4    | —      | —          | —      |                                                                              |
| 2             | "          | 464    | —          | 6·6    | —      | —          | —      |                                                                              |
| 3             | "          | 484    | —          | 6·0    | —      | —          | —      |                                                                              |
| 4             | "          | 486    | —          | 5·4    | —      | —          | —      | The gun was 15 feet right of line.                                           |
| 5             | "          | 458    | —          | 5·0    | —      | —          | —      |                                                                              |
| 6             | "          | 466    | —          | 5·2    | —      | —          | —      |                                                                              |
| 7             | "          | 460    | —          | 6·4    | —      | —          | —      | Weather :—Very slight haze, 10 a.m.<br>Haze on water, 3 p.m.                 |
| 8             | "          | 446    | —          | 5·6    | —      | —          | —      |                                                                              |
| 9             | "          | 462    | —          | 6·0    | —      | —          | —      |                                                                              |
| 10            | "          | 488    | —          | 5·4    | —      | —          | —      | Wind :—Direction, N.E. by N.; force, 2; 10 a.m.<br>" S.E. by S.; " 2; 3 p.m. |
| 11            | "          | 454    | —          | 5·0    | —      | —          | —      |                                                                              |
| 12            | "          | 477    | —          | 6·0    | —      | —          | —      |                                                                              |
| 13            | "          | 478    | —          | 5·2    | —      | —          | —      | Thermometer :—61 dry, 58 wet, 10 a.m.<br>62 " 58 " 3 p.m.                    |
| 14            | "          | 438    | —          | 5·2    | —      | —          | —      |                                                                              |
| 15            | "          | 454    | —          | 4·4    | —      | —          | —      |                                                                              |
| 16            | "          | 469    | —          | 4·4    | —      | —          | —      | Barometer :—30·05 58 10 a.m.<br>30·10 61 3 p.m.                              |
| 17            | "          | 444    | —          | 4·4    | —      | —          | —      |                                                                              |
| 18            | "          | 451    | —          | 5·0    | —      | —          | —      |                                                                              |
| 19            | "          | 500    | —          | 5·0    | —      | —          | —      |                                                                              |
| 20            | "          | 465    | —          | 4·6    | —      | —          | —      |                                                                              |
| 1             | 1          | 858    | —          | 5·4    | —      | 2,500      | 70     | <i>April 5, 1864.</i>                                                        |
| 2             | "          | 856    | —          | 5·4    | —      | 2,480      | 64     |                                                                              |
| 3             | "          | 832    | —          | 7·6    | —      | 2,350      | 54     |                                                                              |
| 4             | "          | 864    | —          | 4·8    | —      | 2,406      | 54     | The gun was placed 15 feet to the right of the line.                         |
| 5             | "          | 853    | —          | 7·6    | —      | 2,554      | 84     |                                                                              |
| 6             | "          | 847    | —          | 5·4    | —      | 2,450      | 58     |                                                                              |
| 7             | "          | 848    | —          | 4·6    | —      | 2,459      | 62     | Weather :—Clear.                                                             |
| 8             | "          | 852    | —          | 5·4    | —      | 2,465      | 38·4   |                                                                              |
| 9             | "          | 845    | —          | 5·0    | —      | 2,276      | 16·4   |                                                                              |
| 10            | "          | 858    | —          | 7·4    | —      | 2,402      | 34     | Wind :—Direction, N.E. by N.; force, 4; 10 a.m.<br>" S.E. by E. " 3; 3 p.m.  |
| 11            | "          | 848    | —          | 3·2    | —      | 2,300      | 52     |                                                                              |
| 12            | "          | 822    | —          | 7·2    | —      | 2,318      | 39     |                                                                              |
| 13            | "          | 845    | —          | 3·2    | —      | 2,383      | 45     | Thermometer :—44 dry, 41 wet, 10 a.m.<br>45 " 42 " 3 p.m.                    |
| 14            | "          | 812    | —          | 5·0    | —      | 2,500      | 38·4   |                                                                              |
| 15            | 2          | 1,113  | —          | 5·4    | —      | 2,640      | 56·0   |                                                                              |

## RANGE AND ACCURACY.—SOLID SHOT—continued.

| No. of Round. | Eleva-<br>tion. | Range. | 1st Graze. |        |        | 2nd Graze. |        | Remarks.                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------|-----------------|--------|------------|--------|--------|------------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |                 |        | In Line.   | Right. | Left.  | Range.     | Right. |                                                                                                                                                                                                                                                                                                                                                                                                           |
|               | °               | Yards. |            | Yards. | Yards. | Yards.     | Yards. |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 1             | 2               | 1,182  | —          | 4.6    | —      | 2,925      | 77.6   | <i>April 11, 1864.</i><br><br>The gun was placed 15 feet to the right of the line.<br><br>Weather :—Very thick haze.<br><br>Wind :—Direction, W.N.W. ; force, nil. ; 10 a.m.<br>"      W.S.W. ; "      1 ; 3 p.m.<br><br>Thermometer :—47 dry, 45 wet, 10 a.m.<br>50 " 51 " 3 p.m.<br><br>Barometer :— <div>Reading.      Temperature.<br/>30.10      52      10 a.m.<br/>30.05      54      3 p.m.</div> |
| 2             | "               | 1,190  | —          | 6.0    | —      | 2,850      | 84     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 3             | "               | 1,149  | —          | 7.2    | —      | 3,070      | 80     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 4             | "               | 1,222  | —          | 7.0    | —      | 3,015      | 82     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 5             | "               | 1,157  | —          | 6.4    | —      | 2,812      | 81.6   |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 6             | "               | 1,187  | —          | 6.2    | —      | 2,939      | 68     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 7             | "               | 1,213  | —          | 7.2    | —      | 2,894      | 64     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 8             | "               | 1,137  | —          | 7.6    | —      | 2,804      | 65     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 9             | "               | 1,220  | —          | 9.0    | —      | 2,759      | 46     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 10            | "               | 1,121  | —          | 6.0    | —      | 2,840      | 51.6   |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 11            | "               | 1,158  | —          | 7.4    | —      | 2,625      | 42     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 12            | "               | 1,200  | —          | 7.0    | —      | 2,708      | 39     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 13            | "               | 1,184  | —          | 6.2    | —      | 2,770      | 67     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 14            | "               | 1,211  | —          | 8.0    | —      | 2,899      | 80     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 15            | "               | 1,160  | —          | 6.4    | —      | 2,840      | 30     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 16            | "               | 1,179  | —          | 9.5    | —      | 2,554      | 31     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 17            | "               | 1,197  | —          | 6.8    | —      | 2,950      | 71     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 18            | "               | 1,156  | —          | 4.0    | —      | 2,750      | 59     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 19            | "               | 1,192  | —          | 6.4    | —      | 2,640      | 70     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 20            | "               | 1,201  | —          | 9.0    | —      | 2,800      | 67     |                                                                                                                                                                                                                                                                                                                                                                                                           |
|               |                 |        |            |        |        |            |        |                                                                                                                                                                                                                                                                                                                                                                                                           |
|               |                 |        |            |        |        |            |        | <i>April 13, 1864.</i>                                                                                                                                                                                                                                                                                                                                                                                    |
| 1             | 3               | 1,489  | —          | 4.4    | —      | —          | —      | The gun was placed in line.<br><br>Weather :—Slight haze on water, 10 a.m.<br>Clear, 3 p.m.<br><br>Wind :—Direction, S.E. by E. ; force, 5 ; 10 a.m.<br>"      E.                   "      5 ; 3 p.m.<br><br>Thermometer :—48 dry, 46 wet, 10 a.m.<br>50 " 46 " 3 p.m.<br><br>Barometer :— <div>Reading.      Temperature.<br/>30.15      52      10 a.m.<br/>30.10      54      3 p.m.</div>             |
| 2             | "               | 1,477  | —          | 1.6    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 3             | "               | 1,499  | —          | 0.4    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 4             | "               | 1,503  | —          | 1.4    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 5             | "               | 1,466  | Yes.       | —      | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 6             | "               | 1,454  | —          | 1.2    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 7             | "               | 1,470  | —          | 0.4    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 8             | "               | 1,502  | —          | 0.4    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 9             | "               | 1,512  | —          | 1.4    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 10            | "               | 1,471  | —          | 0.8    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 11            | "               | 1,517  | —          | 3.0    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 12            | "               | 1,481  | —          | 4.0    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 13            | "               | 1,507  | —          | 1.6    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 14            | "               | 1,486  | —          | 2.0    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 15            | "               | 1,502  | —          | 1.6    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 16            | "               | 1,536  | —          | 1.6    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 17            | "               | 1,466  | —          | 0.8    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 18            | "               | 1,510  | —          | 1.0    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 19            | "               | 1,502  | —          | 1.6    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 20            | "               | 1,420  | —          | 4.8    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
|               |                 |        |            |        |        |            |        |                                                                                                                                                                                                                                                                                                                                                                                                           |
|               |                 |        |            |        |        |            |        | <i>April 14, 1864.</i>                                                                                                                                                                                                                                                                                                                                                                                    |
| 1             | 4               | 1,770  | —          | —      | 2.8    | —          | —      | The gun was 15 feet left of line.<br><br>Weather :—Very slight haze on water, 10 a.m.<br>Clear at 3 p.m.<br><br>Wind :—Direction, E. ; force, 4 ; 10 a.m.<br>"      "      "      6 ; 3 p.m.<br><br>Thermometer :—44 dry, 41 wet, 10 a.m.<br>50 " 47 " 3 p.m.<br><br>Barometer :— <div>Reading.      Temperature.<br/>30.00      51      10 a.m.<br/>30.05      59      3 p.m.</div>                      |
| 2             | "               | 1,762  | —          | —      | 2.5    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 3             | "               | 1,801  | —          | —      | 1.0    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 4             | "               | 1,741  | —          | —      | 2.8    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 5             | "               | 1,760  | —          | —      | 2.0    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 6             | "               | 1,717  | Yes.       | —      | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 7             | "               | 1,803  | —          | —      | 3.2    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 8             | "               | 1,773  | —          | —      | 0.4    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 9             | "               | 1,746  | —          | —      | 3.2    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 10            | "               | 1,748  | —          | —      | 4.8    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 11            | "               | 1,797  | —          | —      | 1.2    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 12            | "               | 1,763  | —          | —      | 3.0    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 13            | "               | 1,767  | —          | —      | 2.8    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 14            | "               | 1,764  | —          | —      | 2.6    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 15            | "               | 1,790  | —          | —      | 1.4    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 16            | "               | 1,744  | —          | —      | 1.6    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 17            | "               | 1,791  | —          | —      | 4.0    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 18            | "               | 1,800  | —          | —      | 3.0    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 19            | "               | 1,758  | —          | 1.6    | —      | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 20            | "               | 1,742  | —          | —      | 3.8    | —          | —      |                                                                                                                                                                                                                                                                                                                                                                                                           |



RANGE AND ACCURACY.—SOLID SHOT—*continued.*

| No. of Round. | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | In Line.   | Right. | Left.  |                                                                                                                                                         |          |              |       |    |       |    |
|               | °            | Yards. |            | Yards. | Yards. | <i>April 15, 1864.</i>                                                                                                                                  |          |              |       |    |       |    |
| 1             | 5            | 2,081  | —          | 8.0    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "            | 2,091  | —          | 9.8    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 2,134  | —          | 11.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "            | 2,130  | —          | 7.4    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "            | 2,166  | —          | 10.4   | —      | The gun was 15 feet right of line.                                                                                                                      |          |              |       |    |       |    |
| 6             | "            | 2,095  | —          | 7.8    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 7             | "            | 2,084  | —          | 11.2   | —      | Weather :—Hazy.                                                                                                                                         |          |              |       |    |       |    |
| 8             | "            | 2,175  | —          | 12.8   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 9             | "            | 2,087  | —          | 12.4   | —      | Wind :—Direction, S.E. by S. ; force, 3 ; 10 a.m.                                                                                                       |          |              |       |    |       |    |
| 10            | "            | 2,114  | —          | 11.4   | —      | " " " 4 ; 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 11            | "            | 2,167  | —          | 9.4    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "            | 2,054  | —          | 13.0   | —      | Thermometer :—51 dry, 48 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 13            | "            | 2,139  | —          | 9.6    | —      | 55 " 52 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 14            | "            | 2,098  | —          | 10.8   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 15            | "            | 2,045  | —          | 12.8   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.75</td><td>52</td></tr><tr><td>29.75</td><td>56</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.75 | 52 | 29.75 | 56 |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29.75         | 52           |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29.75         | 56           |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 16            | "            | 2,096  | —          | 12.8   | —      | 29.75 56 3 p.m.                                                                                                                                         |          |              |       |    |       |    |
| 17            | "            | 2,147  | —          | 12.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 18            | "            | 2,112  | —          | 9.8    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 19            | "            | 2,046  | —          | 16.2   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 20            | "            | 2,096  | —          | 12.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |

April 15, 1864.

|    |   |       |   |      |   |
|----|---|-------|---|------|---|
| 1  | 6 | 2,448 | — | 13.4 | — |
| 2  | " | 2,390 | — | 14.0 | — |
| 3  | " | 2,440 | — | 13.6 | — |
| 4  | " | 2,290 | — | 16.4 | — |
| 5  | " | 2,371 | — | 17.6 | — |
| 6  | " | 2,359 | — | 17.2 | — |
| 7  | " | 2,340 | — | 11.6 | — |
| 8  | " | 2,339 | — | 11.4 | — |
| 9  | " | 2,371 | — | 11.0 | — |
| 10 | " | 2,448 | — | 16.6 | — |
| 11 | " | 2,393 | — | 4.4  | — |
| 12 | " | 2,364 | — | 9.2  | — |
| 13 | " | 2,358 | — | 11.0 | — |
| 14 | " | 2,366 | — | 14.4 | — |
| 15 | " | 2,390 | — | 14.2 | — |
| 16 | " | 2,392 | — | 16.4 | — |
| 17 | " | 2,338 | — | 15.0 | — |
| 18 | " | 2,395 | — | 12.4 | — |
| 19 | " | 2,384 | — | 10.8 | — |
| 20 | " | 2,422 | — | 14.8 | — |

The gun was 15 feet right of line.

Weather :—Hazy.

Wind :—Direction, S.E. by S. ; force, 3 ; 10 a.m.

" " " 4 ; 3 p.m.

Thermometer :—51 dry, 48 wet, 10 a.m.

55 " 52 " 3 p.m.

| Barometer :— | Reading. | Temperature. |         |
|--------------|----------|--------------|---------|
|              | 29.75    | 52           | 10 a.m. |
|              | 29.75    | 56           | 3 p.m.  |

April 15, 1864.

|    |   |       |   |      |   |
|----|---|-------|---|------|---|
| 1  | 7 | 2,660 | — | 14.0 | — |
| 2  | " | 2,730 | — | 15.0 | — |
| 3  | " | 2,698 | — | 16.2 | — |
| 4  | " | 2,720 | — | 15.0 | — |
| 5  | " | 2,635 | — | 11.0 | — |
| 6  | " | 2,628 | — | 9.8  | — |
| 7  | " | 2,712 | — | 14.6 | — |
| 8  | " | 2,642 | — | 12.0 | — |
| 9  | " | 2,716 | — | 17.0 | — |
| 10 | " | 2,681 | — | 13.0 | — |
| 11 | " | 2,608 | — | 8.8  | — |
| 12 | " | 2,652 | — | 14.2 | — |
| 13 | " | 2,705 | — | 13.0 | — |
| 14 | " | 2,649 | — | 14.2 | — |
| 15 | " | 2,705 | — | 13.8 | — |
| 16 | " | 2,679 | — | 12.0 | — |
| 17 | " | 2,656 | — | 8.0  | — |
| 18 | " | 2,704 | — | 10.4 | — |
| 19 | " | 2,697 | — | 15.0 | — |
| 20 | " | 2,694 | — | 13.2 | — |

The gun was 15 feet right of line.

Weather :—Hazy.

Wind :—Direction, S.E. by S. ; force, 3 ; 10 a.m.

" " " 4 ; 3 p.m.

Thermometer :—51 dry, 48 wet, 10 a.m.

55 " 52 " 3 p.m.

| Barometer :— | Reading. | Temperature. |         |
|--------------|----------|--------------|---------|
|              | 29.75    | 52           | 10 a.m. |
|              | 29.75    | 56           | 3 p.m.  |

Li 3

## RANGE AND ACCURACY.—SOLID SHOT—continued.

| No. of Round. | Elevation.   | Range.  | 1st Graze. |        |        | Remarks.                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |              |  |       |    |         |       |    |        |
|---------------|--------------|---------|------------|--------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|--|-------|----|---------|-------|----|--------|
|               |              |         | In Line.   | Right. | Left.  |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
|               | °            | Yards.  |            | Yards. | Yards. |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 1             | 8            | 2,944   | —          | 13·4   | —      | April 25, 1864.<br><br>The gun was 15 feet left of line.<br>Weather :—Clear.<br>Wind :—Direction, E. ; force, 4 ; 10 a.m.<br>" E.S.E. " 3 ; 3 p.m.<br>Thermometer :—51 dry, 48 wet, 10 a.m.<br>52 " 50 " 3 p.m.<br>Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>30·20</td><td>52</td><td>10 a.m.</td></tr><tr><td>30·15</td><td>55</td><td>3 p.m.</td></tr></table>                                    | Reading. | Temperature. |  | 30·20 | 52 | 10 a.m. | 30·15 | 55 | 3 p.m. |
| Reading.      | Temperature. |         |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 30·20         | 52           | 10 a.m. |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 30·15         | 55           | 3 p.m.  |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 2             | "            | 3,010   | —          | 13·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 3             | "            | 3,015   | —          | 11·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 4             | "            | 3,035   | —          | 8·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 5             | "            | 2,923   | —          | 15·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 6             | "            | 2,990   | —          | 15·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 7             | "            | 2,978   | —          | 12·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 8             | "            | 2,996   | —          | 10·6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 9             | "            | 2,959   | —          | 8·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 10            | "            | 2,936   | —          | 12·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 11            | "            | 2,979   | —          | 15·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 12            | "            | 2,963   | —          | 12·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 13            | "            | 2,989   | —          | 12·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 14            | "            | 2,999   | —          | 4·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 15            | "            | 2,990   | —          | 15·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 16            | "            | 2,992   | —          | 9·6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 17            | "            | 2,987   | —          | 8·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 18            | "            | 2,995   | —          | 6·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 19            | "            | 2,959   | —          | 16·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 20            | "            | 2,951   | —          | 11·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
|               |              |         |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 1             | 9            | 3,231   | —          | 8·6    | —      | April 26, 1864.<br><br>The gun was 27 feet right of line.<br>Weather :—Hazy, 10 a.m.<br>Clear, 3 p.m.<br>Wind :—Direction, N.E. by E. ; force, 1 ; 10 a.m.<br>" E. by S. " 2 ; 3 p.m.<br>Thermometer :—52 dry, 49 wet, 10 a.m.<br>52 " 49 " 3 p.m.<br>Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>30·20</td><td>52</td><td>10 a.m.</td></tr><tr><td>30·35</td><td>53</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 30·20 | 52 | 10 a.m. | 30·35 | 53 | 3 p.m. |
| Reading.      | Temperature. |         |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 30·20         | 52           | 10 a.m. |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 30·35         | 53           | 3 p.m.  |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 2             | "            | 3,253   | —          | 11·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 3             | "            | 3,217   | —          | 6·6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 4             | "            | 3,182   | —          | 6·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 5             | "            | 3,245   | —          | 12·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 6             | "            | 3,156   | —          | 5·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 7             | "            | 3,243   | —          | 6·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 8             | "            | 3,238   | —          | 8·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 9             | "            | 3,226   | —          | 12·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 10            | "            | 3,208   | —          | 11·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 11            | "            | 3,222   | —          | 10·6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 12            | "            | 3,185   | —          | 6·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 13            | "            | 3,246   | —          | 2·6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 14            | "            | 3,198   | —          | 6·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 15            | "            | 3,272   | —          | 6·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 16            | "            | 3,214   | —          | 9·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 17            | "            | 3,130   | —          | 12·8   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 18            | "            | 3,227   | —          | 3·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 19            | "            | 3,263   | —          | 2·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 20            | "            | 3,303   | —          | 0·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
|               |              |         |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 1             | 10           | 3,457   | —          | 28·0   | —      | April 27, 1864.<br><br>The gun was 27 feet right of line.<br>Weather :—Hazy, 10 a.m.<br>Slight haze, 3 p.m.<br>Wind :—Direction, E. ; force, 3 ; 10 a.m.<br>" E.S.E. " 4 ; 3 p.m.<br>Thermometer :—49 dry, 47 wet, 10 a.m.<br>50 " 48 " 3 p.m.<br>Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>30·20</td><td>51</td><td>10 a.m.</td></tr><tr><td>30·20</td><td>53</td><td>3 p.m.</td></tr></table>     | Reading. | Temperature. |  | 30·20 | 51 | 10 a.m. | 30·20 | 53 | 3 p.m. |
| Reading.      | Temperature. |         |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 30·20         | 51           | 10 a.m. |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 30·20         | 53           | 3 p.m.  |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 2             | "            | 3,444   | —          | 29·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 3             | "            | 3,462   | —          | 28·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 4             | "            | 3,487   | —          | 35·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 5             | "            | 3,485   | —          | 30·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 6             | "            | 3,436   | —          | 31·6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 7             | "            | 3,458   | —          | 29·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 8             | "            | 3,439   | —          | 24·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 9             | "            | 3,441   | —          | 23·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 10            | "            | 3,485   | —          | 31·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 11            | "            | 3,510   | —          | 29·6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 12            | "            | 3,458   | —          | 23·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 13            | "            | 3,498   | —          | 27·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 14            | "            | 3,486   | —          | 26·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 15            | "            | 3,439   | —          | 23·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 16            | "            | 3,431   | —          | 27·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 17            | "            | 3,448   | —          | 21·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 18            | "            | 3,442   | —          | 23·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 19            | "            | 3,444   | —          | 25·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 20            | "            | 3,464   | —          | 23·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |              |  |       |    |         |       |    |        |



## RANGE AND ACCURACY—continued.

## SHOT.

| No. of Round.  | Elevation. | Range. | 1st Graze. | Remarks.                                       |
|----------------|------------|--------|------------|------------------------------------------------|
|                |            |        | Right.     |                                                |
| June 16, 1864. |            |        |            |                                                |
| 1              | 0          | Yards. | Yards.     | No. 1 gun, 8 feet right of line.               |
| 2              | 15         | 4,738  | 44         | Weather:—Hazy and rain, 10 a.m.                |
| 3              | "          | 4,685  | 40         | Cloudy, 3 p.m.                                 |
| 4              | "          | 4,730  | 51         | Wind:—Direction, N.W. by W.; force, 4; 10 a.m. |
| 5              | "          | 4,700  | 58         | " N.W. " 3; 3 p.m.                             |
| 6              | "          | 4,654  | 56         | Thermometer:—69 dry, 66 wet, 10 a.m.           |
| 7              | "          | 4,668  | 57         | 70 " 69 " 3 p.m.                               |
| 8              | "          | 4,804  | 66         | Reading. Temperature.                          |
| 9              | "          | 4,741  | 52         | Barometer:—29.90 63 10 a.m.                    |
| 10             | "          | 4,776  | 59         | 30.00 64 3 p.m.                                |
|                | "          | 4,700  | 61         |                                                |
| June 27, 1864. |            |        |            |                                                |
| 1              | 25         | 5,910  | 230        | No. 1 gun, 8 feet right of line.               |
| 2              | "          | 6,000  | 256        | Weather:—Cloudy, 10 a.m.                       |
| 3              | "          | 5,940  | 240        | " 3 p.m.                                       |
| 4              | "          | 6,040  | 228        | Wind:—Direction, N.N.W.; force, 4; 10 a.m.     |
| 5              | "          | 6,090  | 229        | " " 3; 3 p.m.                                  |
| 6              | "          | 5,915  | 196        | Thermometer:—61 dry, 55 wet, 10 a.m.           |
| 7              | "          | 6,070  | 198        | 61 " 57 " 3 p.m.                               |
| 8              | "          | 5,954  | 194        | Reading. Temperature.                          |
| 9              | "          | 5,975  | 211        | Barometer:—30.10 59 10 a.m.                    |
| 10             | "          | 6,300  | 234        | 30.15 59 3 p.m.                                |
| June 28, 1864. |            |        |            |                                                |
| 1              | 33         | 6,590  | 207        | No. 1 gun, 8 feet right of line.               |
| 2              | "          | 6,610  | 180        | Weather:—Thick haze on water, 10 a.m.          |
| 3              | "          | 6,685  | 160        | Very thick haze and slight rain, 3 p.m.        |
| 4              | "          | 6,850  | 166        | Wind:—Direction, N.W. by W.; force, 4; 10 a.m. |
| 5              | "          | 6,840  | 171        | " S.W. by W.; " 3; 3 p.m.                      |
| 6              | "          | 6,915  | 180        | Thermometer:—61 dry, 58 wet, 10 a.m.           |
| 7              | "          | 6,780  | 182        | 64 " 61 " 3 p.m.                               |
| 8              | "          | 6,890  | 176        | Reading. Temperature.                          |
| 9              | "          | 6,782  | 166        | Barometer:—30.18 60 10 a.m.                    |
| 10             | "          | 6,743  | 160        | 30.00 62 3 p.m.                                |

## AFTER FIRING 2,800 ROUNDS.

| No. of Round. | Elevation. | Range. | 1st Graze. | Remarks.                                        |
|---------------|------------|--------|------------|-------------------------------------------------|
|               |            |        | Right.     |                                                 |
|               | °          | Yards. | Yards.     |                                                 |
| 1             | 5          | 1,802  | 16.4       | December 22, 1864.                              |
| 2             | "          | 1,885  | 17.6       | Shot.                                           |
| 3             | "          | 1,901  | 15.8       |                                                 |
| 4             | "          | 1,900  | 18.6       | The Gun was on line.                            |
| 5             | "          | 1,820  | 15.8       | Weather :—Clear.                                |
| 6             | "          | 1,847  | 17.6       |                                                 |
| 7             | "          | 1,816  | 16.4       | Wind :—Direction, W. by S. ; force, 4 ; 10 a.m. |
| 8             | "          | 1,836  | 19.0       | " E. " 7 ; 3 p.m.                               |
| 9             | "          | 1,887  | 15.0       |                                                 |
| 10            | "          | 1,886  | 18.8       | Thermometer :—37 dry, 36 wet, 10 a.m.           |
| 11            | "          | 1,852  | 15.0       | 37 " 36 " 3 p.m.                                |
| 12            | "          | 1,825  | 17.4       |                                                 |
| 13            | "          | 1,815  | 13.4       |                                                 |
| 14            | "          | 1,828  | 14.4       | Reading. Temperature.                           |
| 15            | "          | 1,826  | 17.0       | Barometer :—30.12 41 10 a.m.                    |
| 16            | "          | 1,910  | 15.0       | 30.20 41 3 p.m.                                 |
| 17            | "          | 1,856  | 15.4       |                                                 |
| 18            | "          | 1,842  | 13.4       |                                                 |
| 19            | "          | 1,851  | 19.2       |                                                 |
| 20            | "          | 1,875  | 15.2       |                                                 |
| 21            | "          | 1,813  | 15.8       |                                                 |
| 22            | "          | 1,776  | 16.8       |                                                 |

RANGE AND ACCURACY—*continued.*

## COMMON SHELL (weighted with sand).

SHOEBURYNESSE.

*Particulars, &c. of Shell and Ammunition.*

Weight, 10 lbs. 6 oz. empty.

Diameter, 3·074 inches.

Length, 9·02 in.

Bursting charge, 8½ oz.

Length of cartridge, 8·25 inches, including lubricator.

Diameter, 3 inches.

Brand of powder, A4.

Charge, 1½ lbs.

Wad, service lubricator ; no sponging.

| No. of Round. | Elevation. | Range. | 1st Graze, Right. | 2nd Graze. |        | 3rd Graze. |        | Remarks.                                                                                                                                                                                                                                                                                                                                                  |
|---------------|------------|--------|-------------------|------------|--------|------------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |            |        |                   | Range.     | Right. | Range.     | Right. |                                                                                                                                                                                                                                                                                                                                                           |
|               | °          | Yards. | Yards.            | Yards.     | Yards. | Yards.     | Yards. |                                                                                                                                                                                                                                                                                                                                                           |
| 1             | 0          | 527    | 4·8               | 1,878      | 42     | No graze.  |        | <i>April 4, 1864.</i><br>The gun was placed 15 feet to the right of line.<br>Weather:—Hazy at 10 a.m.<br>Slight haze at 3 p.m.<br>Wind:—Direction, S.E. by E. ; force, 1 ; 10 a.m.<br>" N.N.W. ; force, 1 ; 3 p.m.<br>Thermometer:—48 dry, 47 wet, 10 a.m.<br>60 " 58 " 3 p.m.<br>Reading. Temperature.<br>Barometer:—29·75 50 10 a.m.<br>29·95 62 3 p.m. |
| 2             | "          | 512    | 4·4               | 1,600      | 30     | 2,500      | 2      |                                                                                                                                                                                                                                                                                                                                                           |
| 3             | "          | 512    | 5·4               | 1,716      | 56     | 3,575      | 92     |                                                                                                                                                                                                                                                                                                                                                           |

| No. of Round. | Elevation. | Range. | 1st Graze. |        |        | Remarks.                                                               |
|---------------|------------|--------|------------|--------|--------|------------------------------------------------------------------------|
|               |            |        | In Line.   | Right. | Left.  |                                                                        |
|               | °          | Yards. |            | Yards. | Yards. |                                                                        |
| 1             | 0          | 509    | —          | 8·8    | —      | <i>April 27, 1864.</i><br>The gun was 27 feet right of line.           |
| 2             | "          | 477    | —          | 7·8    | —      | Wind:—Direction, E. ; force, 3 ; 10 a.m.                               |
| 3             | "          | 490    | —          | 8·0    | —      | " E.S.E. ; force, 4 ; 3 p.m.                                           |
| 4             | "          | 515    | —          | 8·2    | —      | Thermometer:—49 dry ; 47 wet, 10 a.m.                                  |
| 5             | "          | 507    | —          | 8·2    | —      | 50 " 48 " 3 p.m.                                                       |
| 1             | 1          | 873    | —          | 9·0    | —      | <i>April 27, 1864.</i><br>The gun was 27 feet right of line.           |
| 2             | "          | 871    | —          | 8·8    | —      | Reading. Temperature.                                                  |
| 3             | "          | 860    | —          | 8·0    | —      | Barometer:—30·20 51 10 a.m.                                            |
| 4             | "          | 891    | —          | 8·8    | —      | 30·20 53 3 p.m.                                                        |
| 5             | "          | 837    | —          | 8·4    | —      |                                                                        |
| 1             | 2          | 1,185  | —          | 6·2    | —      | <i>April 11, 1864.</i><br>The gun was placed 15 feet to right of line. |
| 2             | "          | 1,192  | —          | 7·4    | —      | Weather:—Very thick haze.                                              |
| 3             | "          | 1,205  | —          | 7·0    | —      | Wind:—Direction, W.N.W. ; force, nil ; 10 a.m.                         |
| 4             | "          | 1,171  | —          | 5·0    | —      | " W.S.W. ; force, 1 ; 3 p.m.                                           |
| 5             | "          | 1,126  | —          | 5·0    | —      | Thermometer:—47 dry, 45 wet, 10 a.m.<br>45 " 51 " 3 p.m.               |
|               |            |        |            |        |        | Reading. Temperature.                                                  |
|               |            |        |            |        |        | Barometer:—30·10 52 10 a.m.                                            |
|               |            |        |            |        |        | 30·05 54 3 p.m.                                                        |
| 1             | 3          | 1,459  | —          | —      | 6·2    | <i>April 14, 1864.</i><br>The gun was 15 feet to left of line.         |
| 2             | "          | 1,509  | —          | —      | 3·2    | Weather:—Very slight haze on water, 10 a.m.                            |
| 3             | "          | 1,472  | —          | —      | 4·8    | Clear at 3 p.m.                                                        |
| 4             | "          | 1,486  | —          | —      | 3·2    | Wind:—Direction, E. ; force, 4 ; 10 a.m.                               |
| 5             | "          | 1,481  | —          | —      | 5·2    | " E. ; " 6 ; 3 p.m.                                                    |
|               |            |        |            |        |        | Thermometer:—44 dry, 41 wet, 10 a.m.<br>50 " 47 " 3 p.m.               |
|               |            |        |            |        |        | Reading. Temperature.                                                  |
|               |            |        |            |        |        | Barometer:—30·00 51 10 a.m.                                            |
|               |            |        |            |        |        | 30·05 59 3 p.m.                                                        |



## RANGE AND ACCURACY.—COMMON SHELL—continued.

| No. of Round. | Elevation. | Range. | 1st Graze. |        |        | Remarks.                                        |
|---------------|------------|--------|------------|--------|--------|-------------------------------------------------|
|               |            |        | In Line.   | Right. | Left.  |                                                 |
|               | °          | Yards. |            | Yards. | Yards. | <i>April 14, 1864.</i>                          |
| 1             | 4          | 1,685  | —          | —      | 4·0    | The gun was 15 feet to left of line.            |
| 2             | "          | 1,698  | —          | —      | 4·4    |                                                 |
| 3             | "          | 1,749  | —          | —      | 2·0    |                                                 |
| 4             | "          | 1,745  | —          | —      | 4·0    |                                                 |
| 5             | "          | 1,783  | —          | —      | 3·8    |                                                 |
| 1             | 5          | 2,042  | —          | 4·2    | —      | <i>April 14, 1864.</i>                          |
| 2             | "          | 2,051  | —          | —      | 1·4    | The gun was 15 feet left of line.               |
| 3             | "          | 2,000  | —          | —      | 2·4    |                                                 |
| 4             | "          | 2,035  | Yes.       | —      | —      |                                                 |
| 5             | "          | 2,041  | —          | —      | 1·4    |                                                 |
|               |            |        |            |        |        | <i>April 15, 1864.</i>                          |
|               |            |        |            |        |        | The gun was No. 1, 15 feet right of line.       |
| 1             | 6          | 2,352  | —          | 7·0    | —      | Weather :—Hazy.                                 |
| 2             | "          | 2,320  | —          | 8·0    | —      | Wind :—Direction, S.E. by S.; force, 3; 10 a.m. |
| 3             | "          | 2,290  | —          | 7·4    | —      | " " " 4; 3 p.m.                                 |
| 4             | "          | 2,320  | —          | 7·4    | —      | Thermometer :—51 dry; 48 wet; 10 a.m.           |
| 5             | "          | 2,392  | —          | 12·0   | —      | 55 " 52 " 3 p.m.                                |
|               |            |        |            |        |        | Reading. Temperature.                           |
|               |            |        |            |        |        | Barometer :—29·75 52 10 a.m.                    |
|               |            |        |            |        |        | 29·75 56 3 p.m.                                 |
| 1             | 7          | 2,635  | —          | 7·8    | —      | <i>April 15, 1864.</i>                          |
| 2             | "          | 2,647  | —          | 5·4    | —      | The gun was 15 feet right of line.              |
| 3             | "          | 2,708  | —          | 8·0    | —      |                                                 |
| 4             | "          | 2,602  | —          | 9·0    | —      |                                                 |
| 5             | "          | 2,647  | —          | 5·8    | —      |                                                 |
|               |            |        |            |        |        | <i>April 25, 1864.</i>                          |
|               |            |        |            |        |        | The gun was 15 feet left of line.               |
| 1             | 8          | 2,894  | —          | 5·0    | —      | Weather :—Clear.                                |
| 2             | "          | 2,865  | —          | 14·2   | —      | Wind :—Direction, E.; force, 4; 10 a.m.         |
| 3             | "          | 2,856  | —          | 4·6    | —      | " E.S.E.; force, 3; 3 p.m.                      |
| 4             | "          | 2,862  | —          | 6·8    | —      | Thermometer :—51 dry, 48 wet, 10 a.m.           |
| 5             | "          | 2,886  | —          | 4·4    | —      | 52 " 50 " 3 p.m.                                |
|               |            |        |            |        |        | Reading. Temperature.                           |
|               |            |        |            |        |        | Barometer :—30·20 52 10 a.m.                    |
|               |            |        |            |        |        | 30·15 55 3 p.m.                                 |
|               |            |        |            |        |        | <i>April 26, 1864.</i>                          |
|               |            |        |            |        |        | The gun was 27 feet right of line.              |
| 1             | 9          | 3,116  | —          | —      | 4·4    | Weather :—Hazy.                                 |
| 2             | "          | 3,139  | —          | —      | 4·8    | Clear.                                          |
| 3             | "          | 3,057  | —          | —      | 2·6    | Wind :—Direction, N.E. by E.; force, 1; 10 a.m. |
| 4             | "          | 3,103  | —          | —      | 0·8    | " E. by S.; force, 2; 3 p.m.                    |
| 5             | "          | 3,154  | —          | —      | 2·4    | Thermometer :—52 dry, 49 wet, 10 a.m.           |
|               |            |        |            |        |        | 52 " 49 " 3 p.m.                                |
|               |            |        |            |        |        | Reading. Temperature.                           |
|               |            |        |            |        |        | Barometer :—30·20 52 10 a.m.                    |
|               |            |        |            |        |        | 30·35 53 3 p.m.                                 |
|               |            |        |            |        |        | <i>April 27, 1864.</i>                          |
| 1             | 10         | 3,237  | —          | 26·0   | —      | 27 feet right of line.                          |
| 2             | "          | 3,350  | —          | 27·0   | —      | Weather :—Hazy, 10 a.m.                         |
| 3             | "          | 3,308  | —          | 26·0   | —      | Slight haze, 3 p.m.                             |
| 4             | "          | 3,314  | —          | 22·0   | —      | See practice at 1° for weather.                 |
| 5             | "          | 3,258  | —          | 17·2   | —      |                                                 |

RANGE AND ACCURACY—continued.

SEGMENT SHELL (weighted with burster).

SHOEBURYNNESS.

Particulars of Shell and Ammunition.

|                               |                                                         |
|-------------------------------|---------------------------------------------------------|
| Weight, 10 lbs. 8 oz., empty. | Length of cartridge, 8·25 inches, including lubricator. |
| Diameter, 3·074 inches.       | Diameter, 3 inches.                                     |
| Length, 6·76 in.              | Brand of powder, A4.                                    |
| No. of segments, 49.          | Charge, 1½ lbs.                                         |
| Bursting charge, 520 grains.  | Wad, service lubricator ; no sponging.                  |

| No. of Round. | Eleva- tion. | Range. | 1st Graze. |  | 2nd Graze. |        | 3rd Graze. |        | Remarks.                                         |
|---------------|--------------|--------|------------|--|------------|--------|------------|--------|--------------------------------------------------|
|               |              |        | Right.     |  | Range.     | Right. | Range.     | Right. |                                                  |
|               | °            | Yards. | Yards.     |  | Yards.     | Yards. | Yards.     | Yards. |                                                  |
|               |              |        |            |  |            |        |            |        | April 4, 1864.                                   |
| 1             | 0            | 514    | 6·0        |  | 2,256      | 30     | 3,186      | 216    | The gun was 15 feet to the right of line.        |
| 2             | "            | 509    | 4·8        |  | 1,194      | 10     | 2,980      | 32     | Weather:—Hazy at 10 a.m.                         |
| 3             | "            | 525    | 5·0        |  | 2,266      | 44·4   | 2,925      | 40     | Slight haze, 3 p.m.                              |
| 4             | "            | 511    | 5·0        |  | 1,700      | 28·6   | 2,988      | 102    | Wind:—Direction, S.E. by E. ; force, 1 ; 10 a.m. |
| 5             | "            | 468    | 4·4        |  | 2,003      | 44     | 3,222      | 53     | " N.N.W. ; force, 1 ; 3 p.m.                     |
|               |              |        |            |  |            |        |            |        | Thermometer:—48 dry, 47 wet, 10 a.m.             |
|               |              |        |            |  |            |        |            |        | 60 dry, 58 wet, 3 p.m.                           |
|               |              |        |            |  |            |        |            |        | Reading. Temperature.                            |
|               |              |        |            |  |            |        |            |        | Barometer:—29·75 50 10 a.m.                      |
|               |              |        |            |  |            |        |            |        | 29·95 62 3 p.m.                                  |

| No of Round. | Elevation. | Range. | 1st Graze. |        | Remarks.                                       |
|--------------|------------|--------|------------|--------|------------------------------------------------|
|              |            |        | Right.     | Left.  |                                                |
|              | °          | Yards. | Yards.     | Yards. |                                                |
|              |            |        |            |        | April 27, 1864.                                |
| 1            | 1          | 831    | 8·4        | —      | The gun was 27 feet right of line.             |
| 2            | "          | 873    | 9·0        | —      | Weather:—Hazy, at 10 a.m.                      |
| 3            | "          | 865    | 8·4        | —      | Slight haze, 3 p.m.                            |
| 4            | "          | 843    | 9·0        | —      | Wind:—Direction, E. ; force, 3 ; 10 a.m.       |
| 5            | "          | 830    | 9·2        | —      | " E.S.E. " 4 ; 3 p.m.                          |
|              |            |        |            |        | Thermometer:—49 dry, 47 wet, 10 a.m.           |
|              |            |        |            |        | 50 " 48 " 3 p.m.                               |
|              |            |        |            |        | Reading. Temperature.                          |
|              |            |        |            |        | Barometer:—30·20 51 10 a.m.                    |
|              |            |        |            |        | 30·20 53 3 p.m.                                |
|              |            |        |            |        | April 11, 1864.                                |
| 1            | 2          | 1,207  | 7·0        | —      | The gun was 15 feet to the right of line.      |
| 2            | "          | 1,215  | 7·4        | —      | Weather:—Very thick haze.                      |
| 3            | "          | 1,208  | 6·4        | —      | Wind:—Direction, W.N.W. ; force, nil ; 10 a.m. |
| 4            | "          | 1,184  | 5·0        | —      | " W.S.W. ; " 1 ; 3 p.m.                        |
| 5            | "          | 1,195  | 7·0        | —      | Thermometer:—47 dry, 45 wet, 10 a.m.           |
|              |            |        |            |        | 50 " 51 " 3 p.m.                               |
|              |            |        |            |        | Reading. Temperature.                          |
|              |            |        |            |        | Barometer:—30·10 52 10 a.m.                    |
|              |            |        |            |        | 30·05 54 3 p.m.                                |
|              |            |        |            |        | April 14, 1864.                                |
| 1            | 3          | 1,512  | —          | 2·0    | The gun was 15 feet left of line.              |
| 2            | "          | 1,509  | —          | 3·4    | Weather:—Very slight haze on water, 10 a.m.    |
| 3            | "          | 1,506  | —          | 2·0    | Clear, 3 p.m.                                  |
| 4            | "          | 1,468  | —          | 5·6    | Wind:—Direction, E. ; force, 4 ; 10 a.m.       |
| 5            | "          | 1,458  | —          | 0·4    | " E. " 6 ; 3 p.m.                              |
|              |            |        |            |        | Thermometer:—44 dry, 41 wet, 10 a.m.           |
|              |            |        |            |        | 50 " 47 " 3 p.m.                               |
|              |            |        |            |        | Reading. Temperature.                          |
|              |            |        |            |        | Barometer:—30·00 51 10 a.m.                    |
|              |            |        |            |        | 30·05 59 3 p.m.                                |



RANGE AND ACCURACY.—SEGMENT SHELL—*continued.*

| No. of Round.   | Elevation.   | Range.  | 1st Graze. |        | Remarks.                                                                                                                                                                                                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
|-----------------|--------------|---------|------------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|--|-------|----|---------|-------|----|--------|
|                 |              |         | Right.     | Left.  |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
|                 | °            | Yards.  | Yards.     | Yards. |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| April 14, 1864. |              |         |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 1               | 4            | 1,808   | —          | 0·8    | The gun was 15 feet left of line.<br>Thermometer :—44 dry, 41 wet, 10 a.m.<br>50 „ 47 „ 3 p.m.                                                                                                                                                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 2               | „            | 1,783   | —          | 1·0    |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 3               | „            | 1,791   | —          | 1·2    |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 4               | „            | 1,767   | —          | 4·0    |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 5               | „            | 1,782   | —          | 4·4    |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| April 14, 1864. |              |         |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 1               | 5            | 2,041   | 2·2        | —      | The gun was 15 feet left of line.<br>Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>30·00</td><td>51</td><td>10 a.m.</td></tr><tr><td>30·05</td><td>59</td><td>3 p.m.</td></tr></table>                                                                                                                                                     | Reading. | Temperature. |  | 30·00 | 51 | 10 a.m. | 30·05 | 59 | 3 p.m. |
| Reading.        | Temperature. |         |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 30·00           | 51           | 10 a.m. |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 30·05           | 59           | 3 p.m.  |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 2               | „            | 2,070   | 0·2        | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 3               | „            | 1,994   | —          | 2·4    |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 4               | „            | 2,070   | 5·6        | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 5               | „            | 2,036   | 1·0        | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| April 15, 1864. |              |         |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 1               | 6            | 2,390   | 14·8       | —      | The gun was 15 feet right of line.<br>Weather :—Hazy.<br>Wind :—Direction, S.E. by S.; force, 3; 10 a.m.<br>„ „ „ 4; 3 p.m.                                                                                                                                                                                                                                                      |          |              |  |       |    |         |       |    |        |
| 2               | „            | 2,440   | 12·6       | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 3               | „            | 2,402   | 11·0       | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 4               | „            | 2,437   | 9·6        | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 5               | „            | 2,402   | 17·6       | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| April 15, 1864. |              |         |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 1               | 7            | 2,717   | 9·0        | —      | The gun was 15 feet right of line.<br>Thermometer :—51 dry, 48 wet, 10 a.m.<br>55 „ 52 „ 3 p.m.<br>Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>29·75</td><td>52</td><td>10 a.m.</td></tr><tr><td>29·75</td><td>56</td><td>3 p.m.</td></tr></table>                                                                                       | Reading. | Temperature. |  | 29·75 | 52 | 10 a.m. | 29·75 | 56 | 3 p.m. |
| Reading.        | Temperature. |         |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 29·75           | 52           | 10 a.m. |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 29·75           | 56           | 3 p.m.  |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 2               | „            | 2,706   | 10·2       | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 3               | „            | 2,722   | 15·0       | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 4               | „            | 2,737   | 13·0       | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 5               | „            | 2,719   | 15·0       | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| April 25, 1864. |              |         |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 1               | 8            | 2,987   | 9·4        | —      | The gun was 15 feet left of line.<br>Weather :—Clear.<br>Wind :—Direction, E.; force, 4; 10 a.m.<br>„ E.S.E. „ 3; 3 p.m.<br>Thermometer :—51 dry, 48 wet, 10 a.m.<br>52 „ 50 „ 3 p.m.<br>Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>30·20</td><td>52</td><td>10 a.m.</td></tr><tr><td>30·15</td><td>55</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 30·20 | 52 | 10 a.m. | 30·15 | 55 | 3 p.m. |
| Reading.        | Temperature. |         |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 30·20           | 52           | 10 a.m. |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 30·15           | 55           | 3 p.m.  |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 2               | „            | 3,005   | 5·0        | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 3               | „            | 2,989   | 11·2       | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 4               | „            | 3,028   | 8·2        | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 5               | „            | 3,009   | 7·4        | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| April 26, 1864. |              |         |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 1               | 9            | 3,289   | 2·2        | —      | The gun was 15 feet right of line.<br>Weather :—Hazy, 10 a.m.<br>Clear, 3 p.m.<br>Wind :—Direction, N.E. by E.; force, 1; 10 a.m.<br>„ E. by S.; „ 2; 3 p.m.                                                                                                                                                                                                                     |          |              |  |       |    |         |       |    |        |
| 2               | „            | 3,257   | —          | 0·2    |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 3               | „            | 3,208   | 1·0        | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 4               | „            | 3,226   | 1·8        | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 5               | „            | 3,241   | —          | 2·4    |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| April 26, 1864. |              |         |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 1               | 10           | 3,494   | 0·2        | —      | The gun 27 feet to right of line.<br>Thermometer :—52 dry, 49 wet, 10 a.m.<br>52 „ 49 „ 3 p.m.<br>Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>30·20</td><td>52</td><td>10 a.m.</td></tr><tr><td>30·35</td><td>53</td><td>3 p.m.</td></tr></table>                                                                                        | Reading. | Temperature. |  | 30·20 | 52 | 10 a.m. | 30·35 | 53 | 3 p.m. |
| Reading.        | Temperature. |         |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 30·20           | 52           | 10 a.m. |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 30·35           | 53           | 3 p.m.  |            |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 2               | „            | 3,456   | 5·2        | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 3               | „            | 3,438   | 6·4        | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 4               | „            | 3,464   | 5·8        | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 5               | „            | 3,444   | 2·8        | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |

SEGMENT SHELL—continued.

| No. of Round. | Elevation.   | Range.  | 1st Graze. |        |        | Remarks.                                                                                                                                                                                |          |              |  |       |    |         |       |    |        |
|---------------|--------------|---------|------------|--------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|--|-------|----|---------|-------|----|--------|
|               |              |         | In Line.   | Right. | Left.  |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
|               |              | Yards.  |            | Yards. | Yards. |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1             | 0            | 525     | —          | 6·0    | —      | February 22, 1865.                                                                                                                                                                      |          |              |  |       |    |         |       |    |        |
| 2             | "            | 558     | —          | 5·0    | —      | This gun was 15 feet right of line.                                                                                                                                                     |          |              |  |       |    |         |       |    |        |
| 3             | "            | 509     | —          | 7·0    | —      | Weather :—Thick haze on water.                                                                                                                                                          |          |              |  |       |    |         |       |    |        |
| 4             | "            | 501     | —          | 6·0    | —      | Wind :—Direction, W. ; force, 2 ; 10 a.m.                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 5             | "            | 524     | —          | 5·0    | —      | " S.W. by W. ; " 1 ; 3 p.m.                                                                                                                                                             |          |              |  |       |    |         |       |    |        |
| 6             | "            | 518     | —          | 5·6    | —      | Thermometer :—36° dry, 35° wet, 10 a.m.                                                                                                                                                 |          |              |  |       |    |         |       |    |        |
| 7             | "            | 510     | —          | 4·4    | —      | 39 " 38 " 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 8             | "            | 520     | —          | 4·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 9             | "            | 509     | —          | 4·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 10            | "            | 544     | —          | 3·6    | —      | To correspond with Whitworth.                                                                                                                                                           |          |              |  |       |    |         |       |    |        |
| 11            | "            | 500     | —          | 5·6    | —      | Ditto ditto.                                                                                                                                                                            |          |              |  |       |    |         |       |    |        |
| 12            | "            | 555     | —          | 5·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 13            | "            | 524     | —          | 4·4    | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>30·27</td><td>38</td><td>10 a.m.</td></tr><tr><td>30·25</td><td>41</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 30·27 | 38 | 10 a.m. | 30·25 | 41 | 3 p.m. |
| Reading.      | Temperature. |         |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 30·27         | 38           | 10 a.m. |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 30·25         | 41           | 3 p.m.  |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 14            | "            | 534     | —          | 3·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 15            | "            | 475     | —          | 5·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 16            | "            | 494     | —          | 5·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 17            | "            | 480     | —          | 4·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 18            | "            | 509     | —          | 4·8    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19            | "            | 505     | —          | 3·4    | —      | To correspond with Whitworth.                                                                                                                                                           |          |              |  |       |    |         |       |    |        |
| 20            | "            | 514     | —          | 4·8    | —      | Ditto ditto.                                                                                                                                                                            |          |              |  |       |    |         |       |    |        |
| 21            | "            | 490     | —          | 4·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 22            | "            | 465     | —          | 5·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1             | 3            | 1,492   | —          | 11·4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 2             | "            | 1,479   | —          | 7·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3             | "            | 1,455   | —          | 7·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 4             | "            | 1,475   | —          | 9·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 5             | "            | 1,431   | —          | 8·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 6             | "            | 1,454   | —          | 9·8    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 7             | "            | 1,416   | —          | 7·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 8             | "            | 1,429   | —          | 7·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 9             | "            | 1,454   | —          | 6·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 10            | "            | 1,439   | —          | 7·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 11            | "            | 1,426   | —          | 7·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 12            | "            | 1,435   | —          | 8·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 13            | "            | 1,434   | —          | 5·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 14            | "            | 1,449   | —          | 6·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 15            | "            | 1,432   | —          | 8·6    | —      | To correspond with Whitworth.                                                                                                                                                           |          |              |  |       |    |         |       |    |        |
| 16            | "            | 1,427   | —          | 9·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 17            | "            | 1,442   | —          | 8·0    | —      | Ditto ditto.                                                                                                                                                                            |          |              |  |       |    |         |       |    |        |
| 18            | "            | 1,427   | —          | 8·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19            | "            | 1,432   | —          | 6·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20            | "            | 1,487   | —          | 7·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 21            | "            | 1,421   | —          | 9·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 22            | "            | 1,449   | —          | 7·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1             | 5            | 1,948   | —          | 4·0    | —      | To correspond with Whitworth.                                                                                                                                                           |          |              |  |       |    |         |       |    |        |
| 2             | "            | 2,022   | —          | 8·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3             | "            | 2,079   | —          | 9·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 4             | "            | 2,099   | —          | 9·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 5             | "            | 2,027   | —          | 11·0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 6             | "            | 2,110   | —          | 10·0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 7             | "            | 2,051   | —          | 7·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 8             | "            | 2,055   | —          | 6·8    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 9             | "            | 2,110   | —          | 13·0   | —      | Ditto ditto.                                                                                                                                                                            |          |              |  |       |    |         |       |    |        |
| 10            | "            | 2,053   | —          | 6·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 11            | "            | 2,117   | —          | 11·8   | —      | Ditto ditto.                                                                                                                                                                            |          |              |  |       |    |         |       |    |        |
| 12            | "            | 2,135   | —          | 8·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 13            | "            | 2,042   | —          | 7·8    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 14            | "            | 2,115   | —          | 9·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 15            | "            | 2,078   | —          | 8·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 16            | "            | 2,072   | —          | 8·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 17            | "            | 2,139   | —          | 13·0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 18            | "            | 1,957   | —          | 6·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19            | "            | 2,078   | —          | 8·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20            | "            | 2,147   | —          | 12·4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 21            | "            | 2,139   | —          | 16·0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 22            | "            | 2,058   | —          | 13·0   | —      | Thomas Wilson.                                                                                                                                                                          |          |              |  |       |    |         |       |    |        |



## SEGMENT SHELL—continued.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                              |          |              |       |    |
|---------------|--------------|--------|------------|--------|--------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|               |              |        | In Line.   | Right. | Left.  |                                                                                                                       |          |              |       |    |
|               |              | Yards. |            | Yards. | Yards. |                                                                                                                       |          |              |       |    |
| 1             | 7            | 2,614  | —          | 13·6   | —      | <i>February 23, 1865.</i>                                                                                             |          |              |       |    |
| 2             | "            | 2,686  | —          | 15·2   | —      | This gun was on the line.                                                                                             |          |              |       |    |
| 3             | "            | 2,732  | —          | 11·2   | —      | Weather :—Very thick haze on water, 10 a.m.                                                                           |          |              |       |    |
| 4             | "            | 2,684  | —          | 7·2    | —      | Hazy, 3 p.m.                                                                                                          |          |              |       |    |
| 5             | "            | 2,612  | —          | 3·6    | —      | Wind :—Direction, W. by N. ; force, 3 ; 10 a.m.                                                                       |          |              |       |    |
| 6             | "            | 2,654  | —          | 11·2   | —      | " N.W. by W. ; " 3 ; 3 p.m.                                                                                           |          |              |       |    |
| 7             | "            | 2,604  | —          | 9·4    | —      | Thermometer :—42 dry, 41 wet, 10 a.m.                                                                                 |          |              |       |    |
| 8             | "            | 2,624  | —          | 9·6    | —      | " 47 " 46 " 3 p.m.                                                                                                    |          |              |       |    |
| 9             | "            | 2,572  | —          | 14·2   | —      |                                                                                                                       |          |              |       |    |
| 10            | "            | 2,636  | —          | 18·4   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·30</td><td>41</td></tr></table> 10 a.m. | Reading. | Temperature. | 30·30 | 41 |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                       |          |              |       |    |
| 30·30         | 41           |        |            |        |        |                                                                                                                       |          |              |       |    |
| 11            | "            | 2,571  | —          | 14·0   | —      | " 30·30 46 3 p.m.                                                                                                     |          |              |       |    |
| 12            | "            | 2,662  | —          | 1·4    | —      |                                                                                                                       |          |              |       |    |
| 13            | "            | 2,695  | —          | 5·4    | —      |                                                                                                                       |          |              |       |    |
| 14            | "            | 2,718  | —          | 8·0    | —      | } To correspond with Whitworth broken at muzzle.                                                                      |          |              |       |    |
| 15            | "            | 2,556  | —          | 2·2    | —      |                                                                                                                       |          |              |       |    |
| 16            | "            | 2,546  | —          | 2·8    | —      |                                                                                                                       |          |              |       |    |
| 17            | "            | 2,636  | —          | 4·0    | —      |                                                                                                                       |          |              |       |    |
| 18            | "            | 2,572  | —          | 7·0    | —      |                                                                                                                       |          |              |       |    |
| 19            | "            | 2,627  | —          | 3·2    | —      | Do. do.                                                                                                               |          |              |       |    |
| 20            | "            | 2,642  | —          | 2·0    | —      |                                                                                                                       |          |              |       |    |
| 21            | "            | 2,635  | —          | 5·6    | —      |                                                                                                                       |          |              |       |    |
| 22            | "            | 2,694  | —          | 6·0    | —      |                                                                                                                       |          |              |       |    |
|               |              |        |            |        |        |                                                                                                                       |          |              |       |    |
| 1             | 10           | 3,388  | —          | —      | 0·8    |                                                                                                                       |          |              |       |    |
| 2             | "            | 3,342  | —          | —      | 9·0    |                                                                                                                       |          |              |       |    |
| 3             | "            | lost   | —          | —      | —      |                                                                                                                       |          |              |       |    |
| 4             | "            | 3,784  | —          | —      | —      | } To correspond with Whitworth broken at muzzle.                                                                      |          |              |       |    |
| 5             | "            | 3,246  | —          | —      | 1·2    |                                                                                                                       |          |              |       |    |
| 6             | "            | 3,418  | —          | —      | 2·2    |                                                                                                                       |          |              |       |    |
| 7             | "            | 3,150  | —          | 44     | —      |                                                                                                                       |          |              |       |    |
| 8             | "            | 3,395  | —          | —      | 0·8    |                                                                                                                       |          |              |       |    |
| 9             | "            | 3,419  | —          | —      | 6·0    |                                                                                                                       |          |              |       |    |
| 10            | "            | 3,322  | —          | —      | 3·4    | Do. do.                                                                                                               |          |              |       |    |
| 11            | "            | 3,454  | —          | 4·0    | —      |                                                                                                                       |          |              |       |    |
| 12            | "            | 3,369  | —          | —      | 6·4    | Do. do.                                                                                                               |          |              |       |    |
| 13            | "            | 3,291  | —          | 1·0    | —      |                                                                                                                       |          |              |       |    |
| 14            | "            | 3,395  | Yes.       | —      | —      |                                                                                                                       |          |              |       |    |
| 15            | "            | 3,330  | —          | —      | 9·2    |                                                                                                                       |          |              |       |    |
| 16            | "            | 3,382  | —          | 5·4    | —      |                                                                                                                       |          |              |       |    |
| 17            | "            | 3,241  | —          | 5·2    | —      |                                                                                                                       |          |              |       |    |
| 18            | "            | 3,171  | Yes.       | —      | —      |                                                                                                                       |          |              |       |    |
| 19            | "            | 3,071  | —          | —      | 6·4    |                                                                                                                       |          |              |       |    |
| 20            | "            | 3,116  | —          | —      | 12·2   | To correspond with M.L. Armstrong not seen.                                                                           |          |              |       |    |
| 21            | "            | 3,220  | —          | 3·0    | —      |                                                                                                                       |          |              |       |    |
| 22            | "            | 3,142  | —          | 2·4    | —      |                                                                                                                       |          |              |       |    |
| 23            | "            | 3,281  | —          | 1·8    | —      |                                                                                                                       |          |              |       |    |
| 24            | "            | 3,147  | —          | 0·2    | —      |                                                                                                                       |          |              |       |    |

# TARGET PRACTICE.

## SOLID SHOT.

*April 5, 1864.*

The firing was carried on against wooden targets divided into squares of 12 inches, inscribed circle in centre square being the bull's eye.

RANGE, 200 yards. Five trial shots. Elevation, 15". Deflection, nil.

|        |       |                     |
|--------|-------|---------------------|
| No. 1. | 6     | inches from centre. |
| " 2.   | 9     | " "                 |
| " 3.   | 13    | " "                 |
| " 4.   | 10·75 | " "                 |
| " 5.   | 19·5  | " "                 |

RANGE, 300 yards. Five trial shots. Elevation, 21". Deflection, 4' left.

|        |       |                     |
|--------|-------|---------------------|
| No. 1. | 8     | inches from centre. |
| " 2.   | 19·25 | " "                 |
| " 3.   | 27·5  | " "                 |
| " 4.   | 13·5  | " "                 |
| " 5.   | 6·25  | " "                 |

RANGE, 400 yards. Five trial shots. Elevation, 37". Deflection, 5" left.

|        |       |                     |
|--------|-------|---------------------|
| No. 1. | 6     | inches from centre. |
| " 2.   | 10    | " "                 |
| " 3.   | 34·5  | " "                 |
| " 4.   | 25·75 | " "                 |
| " 5.   | 28·5  | " "                 |

*April 6, 1864.*

RANGE, 500 yards. Three trial shots. Elevation, 45". Deflection, 4' left.

|        |      |                     |
|--------|------|---------------------|
| No. 1. | 17·5 | inches from centre. |
| " 2.   | 42   | " "                 |
| " 3.   | 9·5  | " "                 |
| " 4.   | 44·5 | " "                 |
| " 5.   | 24   | " "                 |

*April 6, 1864—continued.*

RANGE, 600 yards. Two trial shots. Elevation, 7". Deflection, 6' left.

|        |       |                     |
|--------|-------|---------------------|
| No. 1. | 24    | inches from centre. |
| " 2.   | 53    | " "                 |
| " 3.   | 29    | " "                 |
| " 4.   | miss. | " "                 |
| " 5.   | 30    | " "                 |

*April 7, 1864.*

RANGE, 800 yards. Three trial shots. Elevation, 1° 26'. Deflection, 4' left.

|        |       |                     |
|--------|-------|---------------------|
| No. 1. | 51·5  | inches from centre. |
| " 2.   | 49    | " "                 |
| " 3.   | 21·5  | " "                 |
| " 4.   | 42·25 | " "                 |
| " 5.   | 22·5  | " "                 |

RANGE, 900 yards. Five trial shots. Elevation, 1° 43'. Deflection, 7' left.

|        |      |                     |
|--------|------|---------------------|
| No. 1. | 36   | inches from centre. |
| " 2.   | 31·5 | " "                 |
| " 3.   | 49   | " "                 |
| " 4.   | 13   | " "                 |
| " 5.   | 19·5 | " "                 |

*April 8, 1864.*

RANGE, 1,300 yards. Five trial shots. Elevation, 2° 53' for Nos. 1 and 2. Deflection, 13' left, for Nos. 1 and 2. Elevation, 2° 49' for Nos. 3, 4, and 5. Deflection, 10' for Nos. 3, 4, and 5.

|        |                          |
|--------|--------------------------|
| No. 1. | miss.                    |
| " 2.   | miss.                    |
| " 3.   | 16·0 inches from centre. |
| " 4.   | miss.                    |
| " 5.   | 47·0 " "                 |



TARGET PRACTICE.—SOLID SHOT—continued.

April 29, 1864.

May 10 and 12, 1864.

RANGE, 1,700 yards. Three 9-foot targets. Five trial shots not recorded.

RANGE, 2,000 yards. Three 9 feet targets. Five trial shots not recorded.

| No. of Round. | Inches from Centre. | 1st Graze. |       |        |        | No. of Round. | Inches from Centre. | 1st Graze. |       |        |        |
|---------------|---------------------|------------|-------|--------|--------|---------------|---------------------|------------|-------|--------|--------|
|               |                     | Right.     | Left. | Short. | Over.  |               |                     | Right.     | Left. | Short. | Over.  |
|               |                     | Feet.      | Feet. | Yards. | Yards. |               |                     | Feet.      | Feet. | Yards. | Yards. |
| 1             | 124                 | —          | —     | —      | —      | 1             | —                   | —          | 10    | —      | 25     |
| 2             | 20 $\frac{1}{4}$    | —          | —     | —      | —      | 2             | —                   | —          | 4     | 3      | —      |
| 3             | —                   | —          | 4     | 40     | —      | 3             | —                   | —          | 10    | 22     | —      |
| 4             | 34 $\frac{1}{2}$    | —          | —     | —      | —      | 4             | —                   | —          | —     | 200    | —      |
| 5             | —                   | —          | 9     | 10     | —      | 5             | —                   | 3          | —     | 12     | —      |
| 6             | —                   | —          | 12    | 2      | —      | 6             | —                   | —          | 4     | 52     | —      |
| 7             | —                   | —          | 2     | —      | 36     | 7             | —                   | —          | 9     | 40     | —      |
| 8             | —                   | —          | 11    | 11     | —      | 8             | —                   | —          | 3     | 100    | —      |
| 9             | —                   | —          | 7     | 15     | —      | 9             | —                   | —          | 6     | 102    | —      |
| 10            | —                   | 14         | —     | —      | 2      | 10            | —                   | —          | 2     | 15     | —      |
| 11            | —                   | —          | —     | 23     | —      | 11            | —                   | —          | 8     | —      | 60     |
| 12            | —                   | —          | 6     | 8      | —      | 12            | —                   | —          | —     | 90     | —      |
| 13            | 63 $\frac{1}{2}$    | —          | —     | —      | —      | 13            | —                   | —          | 10    | —      | 80     |
| 14            | 102 $\frac{1}{2}$   | —          | —     | —      | —      | 14            | 29                  | —          | —     | —      | —      |
| 15            | —                   | 3          | —     | —      | 44     | 15            | —                   | 2          | —     | —      | 25     |
| 16            | 110 $\frac{1}{2}$   | —          | —     | —      | —      | 16            | 69 $\frac{1}{2}$    | —          | —     | —      | —      |
| 17            | 51                  | —          | —     | —      | —      | 17            | —                   | —          | —     | —      | 35     |
| 18            | —                   | —          | 3     | 18     | —      | 18            | —                   | 9          | —     | —      | 30     |
| 19            | —                   | 3          | —     | 3      | —      | 19            | 90 $\frac{1}{2}$    | —          | —     | —      | —      |
| 20            | —                   | —          | 4     | 31     | —      | 20            | —                   | 2          | —     | 8      | —      |

May 11 and 12, 1864.

RANGE, 3,000 yards. Three 9-foot targets. Five trial shots not recorded.

| No. of Round. | Inches from Centre. | 1st Graze. |       |        |        |
|---------------|---------------------|------------|-------|--------|--------|
|               |                     | Right.     | Left. | Short. | Over.  |
|               |                     | Feet.      | Feet. | Yards. | Yards. |
| 1             | —                   | —          | 18    | 50     | —      |
| 2             | —                   | —          | 9     | 45     | —      |
| 3             | —                   | —          | —     | 46     | —      |
| 4             | —                   | —          | 24    | —      | 44     |
| 5             | —                   | 2          | —     | —      | 17     |
| 6             | —                   | 5          | —     | —      | 16     |
| 7             | —                   | —          | —     | 18     | —      |
| 8             | —                   | —          | 30    | 56     | —      |
| 9             | 69                  | —          | —     | —      | —      |
| 10            | —                   | 15         | —     | 8      | —      |
| 11            | —                   | —          | 28    | 70     | —      |
| 12            | —                   | —          | 9     | 72     | —      |
| 13            | —                   | —          | 6     | 60     | —      |
| 14            | —                   | 6          | —     | 20     | —      |
| 15            | —                   | 20         | —     | —      | 36     |
| 16            | —                   | —          | 18    | —      | 70     |
| 17            | —                   | —          | —     | —      | 50     |
| 18            | —                   | —          | —     | —      | 45     |
| 19            | —                   | —          | —     | —      | 14     |
| 20            | 13                  | —          | —     | —      | —      |

TARGET PRACTICE—continued.

SEGMENT SHELL (BLIND).

April 28 and 29, 1864.

May 18, 1864.

RANGE, 1,500 yards. Three 9-foot targets. Five trial shots not recorded.

RANGE, 2,600 yards. Three 9-foot targets. Five trial shots not recorded.

| No. of Round. | Inches from Centre. | 1st Graze. |       |        |        | No. of Round. | Inches from Centre. | 1st Graze. |       |        |        |
|---------------|---------------------|------------|-------|--------|--------|---------------|---------------------|------------|-------|--------|--------|
|               |                     | Right.     | Left. | Short. | Over.  |               |                     | Right.     | Left. | Short. | Over.  |
|               |                     | Feet.      | Feet. | Yards. | Yards. |               |                     | Feet.      | Feet. | Yards. | Yards. |
| 1             | 113                 | —          | —     | —      | —      | 1             | —                   | —          | —     | 140    | —      |
| 2             | 56                  | —          | —     | —      | —      | 2             | 45 $\frac{1}{4}$    | —          | —     | —      | —      |
| 3             | 65 $\frac{3}{4}$    | —          | —     | —      | —      | 3             | —                   | —          | —     | —      | 50     |
| 4             | 37 $\frac{1}{4}$    | —          | —     | —      | —      | 4             | —                   | —          | —     | 44     | —      |
| 5             | —                   | —          | —     | —      | 47     | 5             | 88 $\frac{1}{4}$    | —          | —     | —      | —      |
| 6             | —                   | —          | —     | —      | 46     | 6             | —                   | —          | 6     | —      | 35     |
| 7             | —                   | —          | —     | —      | 42     | 7             | —                   | —          | —     | 20     | —      |
| 8             | 58 $\frac{1}{2}$    | —          | —     | —      | —      | 8             | —                   | 3          | —     | 18     | —      |
| 9             | 46 $\frac{3}{4}$    | —          | —     | —      | —      | 9             | —                   | —          | 5     | 5      | —      |
| 10            | —                   | —          | —     | —      | 45     | 10            | —                   | —          | 9     | 18     | —      |
| 11            | —                   | 1          | —     | —      | 48     | 11            | —                   | —          | —     | 56     | —      |
| 12            | —                   | 4          | —     | —      | 49     | 12            | —                   | —          | —     | 25     | —      |
| 13            | 57 $\frac{1}{2}$    | —          | —     | —      | —      | 13            | —                   | —          | —     | —      | 25     |
| 14            | —                   | 5          | —     | —      | 42     | 14            | —                   | —          | —     | 170    | —      |
| 15            | 43 $\frac{1}{4}$    | —          | —     | —      | —      | 15            | —                   | —          | —     | 100    | —      |
| 16            | —                   | —          | —     | 20     | —      | 16            | —                   | —          | 10    | 75     | —      |
| 17            | —                   | —          | 3     | 3      | —      | 17            | —                   | —          | 6     | —      | 25     |
| 18            | 26 $\frac{1}{2}$    | —          | —     | —      | —      | 18            | —                   | —          | 8     | 60     | —      |
| 19            | 13                  | —          | —     | —      | —      | 19            | —                   | 6          | —     | 18*    | —      |
| 20            | 56 $\frac{1}{2}$    | —          | —     | —      | —      | 20            | —                   | 10         | —     | 100    | —      |

\* Broke up.

May 18, 1864.

RANGE, 3,000 yards. Three 9-foot targets. Five trial shots not recorded.

| No. of Round. | Inches from Centre. | 1st Graze. |       |        |        |
|---------------|---------------------|------------|-------|--------|--------|
|               |                     | Right.     | Left. | Short. | Over.  |
|               |                     | Feet.      | Feet. | Yards. | Yards. |
| 1             | —                   | 4          | —     | —      | 44     |
| 2             | —                   | —          | 15    | —      | 20     |
| 3             | —                   | —          | 6     | —      | 50     |
| 4             | —                   | —          | 10    | 30     | —      |
| 5             | —                   | —          | 4     | —      | 56     |
| 6             | —                   | —          | —     | —      | 50     |
| 7             | 53 $\frac{1}{2}$    | —          | —     | —      | —      |
| 8             | —                   | —          | 6     | —      | 60     |
| 9             | —                   | —          | 3     | —      | 25     |
| 10            | —                   | —          | —     | 40     | —      |
| 11            | —                   | —          | —     | 20     | —      |
| 12            | —                   | —          | 6     | 85     | —      |
| 13            | —                   | —          | 18    | 3      | —      |
| 14            | —                   | 9          | —     | 20     | —      |
| 15            | —                   | —          | —     | 160    | —      |
| 16            | —                   | 4          | —     | 106    | —      |
| 17            | —                   | —          | 60    | 360    | —      |
| 18            | —                   | 6          | —     | —      | 25     |
| 19            | —                   | 9          | —     | 46     | —      |
| 20            | —                   | 16         | —     | 20     | —      |



TARGET PRACTICE—continued.

COMMON SHELL (BLIND).

April 6, 1864.

RANGE, 700 yards. One 9-ft. target. Two trial shots. Elevation, 1° 15'. Deflection, 4' left.

No. 1. 47 inches from centre.  
" 2. 53 " "  
" 3. 37 " "  
" 4. 37 " "  
" 5. 52.5 " "

April 28, 1864.

RANGE, 1,200 yards. Three 9-foot targets. Five trial shots not recorded.

| No. of Round. | Inches from Centre. | 1st Graze in Yards. |       |        |        |
|---------------|---------------------|---------------------|-------|--------|--------|
|               |                     | Right.              | Left. | Short. | Over.  |
|               |                     |                     |       | Yards. | Yards. |
| 1             | 15½                 | —                   | —     | —      | —      |
| 2             | 58½                 | —                   | —     | —      | —      |
| 3             | 61¾                 | —                   | —     | —      | —      |
| 4             | —                   | —                   | —     | —      | —      |
| 5             | 28¾                 | —                   | —     | —      | —      |
| 6             | 28½                 | —                   | —     | —      | —      |
| 7             | 52                  | —                   | —     | —      | —      |
| 8             | 58                  | —                   | —     | —      | —      |
| 9             | 35                  | —                   | —     | —      | —      |
| 10            | 68½                 | —                   | —     | —      | —      |
| 11            | 37                  | —                   | —     | —      | —      |
| 12            | —                   | —                   | —     | —      | 54     |
| 13            | 46                  | —                   | —     | —      | —      |
| 14            | 36                  | —                   | —     | —      | —      |
| 15            | —                   | —                   | —     | —      | 50     |
| 16            | —                   | —                   | —     | —      | 50     |
| 17            | 42                  | —                   | —     | —      | —      |
| 18            | 54                  | —                   | —     | —      | —      |
| 19            | 36                  | —                   | —     | —      | —      |
| 20            | —                   | —                   | —     | 1      | —      |

## EXPERIMENTS AGAINST EARTHWORK AND ABBATIS.

April 8, 1864.

The following practice was carried on against an earthwork with three embrasures, armed with guns on garrison carriages, wood figures of men round each gun. Two 9-foot targets, 6 feet in rear of each gun. The work and faces of the embrasure were revetted with Jones' gabions.

RANGE, 1,300 yards.

| No. | Elevation. | Deflection. | Projectile. | Fuze.       |
|-----|------------|-------------|-------------|-------------|
|     | ° /        | '           |             | '           |
| 1   | 2 54       | 10 left     | Solid shot  | —           |
| 2   | "          | 10 "        | "           | —           |
| 3   | 2 57       | 10 "        | "           | —           |
| 4   | "          | 10 "        | "           | —           |
| 5   | 2 55       | 11 "        | "           | —           |
| 6   | "          | 11 "        | Seg. shell  | T. & P. 2'1 |
| 7   | "          | 12 "        | "           | 2'1         |
| 8   | 2 56       | 13 "        | "           | 2'05        |
| 9   | "          | 13 "        | "           | 2'1         |
| 10  | "          | 13 "        | "           | "           |

The firing was carried on against the embrasure; both time and percussion fuzes used.

The general results could alone be tabulated. They are as follows:—

15 hits on target; 6 through; 5 men hit.

RANGE, 900 yards.

| No. | Elevation. | Deflection. | Projectile. | Fuze.         |
|-----|------------|-------------|-------------|---------------|
|     | ° /        | '           |             | '             |
| 1   | 1 44       | 7 left      | Solid shot  | —             |
| 2   | 1 45       | 7'5 "       | "           | —             |
| 3   | 1 46       | 7'5 "       | "           | —             |
| 4   | "          | 7'5 "       | "           | —             |
| 5   | 1 47       | 8 "         | "           | —             |
| 6   | 1 49       | 7 "         | Seg. shell  | 1'4 & per.    |
| 7   | "          | 7 "         | "           | "             |
| 8   | "          | 7 "         | "           | "             |
| 9   | "          | 7 "         | "           | "             |
| 10  | "          | 7 "         | "           | "             |
| 11  | 1 45       | 7 "         | Com. shell  | Percus. only. |
| 12  | "          | 9 "         | "           | "             |
| 13  | "          | 10 "        | "           | "             |
| 14  | "          | 10 "        | "           | "             |
| 15  | "          | 10 "        | "           | "             |
| 16  | "          | 10 "        | "           | "             |
| 17  | "          | 10 "        | "           | "             |
| 18  | "          | 10 "        | "           | "             |
| 19  | "          | 10 "        | "           | "             |
| 20  | "          | 10 "        | "           | "             |

The solid shot and segment shell were fired at the embrasure, the common shell to damage the merlon.

The general results are as follows:—

Both capsquares of the gun broken and the carriage damaged; 5 figures struck; 65 holes through the target; 2 struck; 11 lodged.

April 11, 1864.

RANGE, 700 yards against embrasures.

| No. | Elevation. | Deflection. | Projectile. | Fuze.          |
|-----|------------|-------------|-------------|----------------|
|     | ° /        | '           |             | '              |
| 1   | 1 12       | 5 left      | Shot        | —              |
| 2   | "          | 10 "        | "           | —              |
| 3   | "          | 10 "        | "           | —              |
| 4   | "          | 11 "        | "           | —              |
| 5   | 1 14       | 11 "        | "           | —              |
| 6   | "          | 11 "        | Seg. shell  | 1'05 & percus. |
| 7   | 1 15       | 11 "        | "           | " "            |
| 8   | "          | 11 "        | "           | " "            |
| 9   | "          | 8 "         | "           | " "            |
| 10  | "          | 8 "         | "           | " "            |
| 11  | 1 12       | 8 "         | Com. shell  | Percussion.    |
| 12  | "          | 8 "         | "           | "              |
| 13  | 1 13'5     | 8 "         | "           | "              |
| 14  | 1 15       | 8 "         | "           | "              |
| 15  | "          | 8 "         | "           | "              |

The general results are as follows:—

On target, 65 through; 15 lodged; 11 struck; 3 figures struck.

## ABBATIS.

RANGE, 600 yards.

5 round solid shot.

5 " segment shell, percussion fuze.

5 " common shell, do. do.

The common shell had little effect. The shot and segment shell, however, damaged it very considerably and made it quite practicable for assault.



## EXPERIMENTS AGAINST STOCKADES, WALLS, FIELD ARTILLERY, AND ROPE MANTLETS.

### STOCKADES.

*Shoeburyness, April 18, 1864.*

The stockade, 18 feet long, 8 feet high, consisted of rough elm timbers, freshly felled, 12 feet long and 14 inches in thickness; the ends were sunk four feet in the ground, and the stockade strengthened by a strong oak brace in rear.

RANGE, 800 yards.

Targets 6 feet in rear to show the effect of the shell.

10 segment shell,  
10 common shell

were fired; the stockade, although but little damaged, owing to the wood being green, afforded no protection whatever, the targets in rear being broken to pieces.

As regards destructive effect there was no choice between the guns.

### WALLS.

The wall, 18 feet long, 8 feet high, 28 inches in thickness, was built of the best stock bricks and cement.

RANGE, 1,150 yards.

Targets 6 feet in rear to show the effect of the shell.

5 rounds solid shot.  
5 „ segment shell.  
5 „ common shell,

were fired. At the conclusion of the practice there

appeared to be very little difference in the amount of damage done by the guns.

That fired at by—

B.L. Armstrong was most damaged.

M.L. Armstrong „ next.

Whitworth „ next.

As regards the targets in rear, the relative damage done by the splinters of shells was as follows:—

M.L. Armstrong, most damage, most distributed.

B.L. „ next „ most concentrated.

Whitworth least damage, considerably less so than either of the other two.

### PRACTICE WITH SEGMENT SHELL AGAINST FIELD ARTILLERY.

Percussion fuse used throughout.

A 6-pounder field gun was placed in action, with limber in rear; dummy figures were placed to represent the gun detachment.

RANGE, 1,000 yards.

A screen was placed in front so as to ensure the shell bursting 25 yards in front of the gun.

1. Missed the screen and grazed 13 yards in front of the gun; 5 of the gun detachment struck; 4 hits on the gun carriage; 1 hit on the limber.
2. Hit the screen 3 feet 4 inches from the ground; 4 of the gun detachment struck; 1 hit on the gun carriage.
3. Passed through the foot of the screen; 4 of the gun detachment struck; 1 hit on the gun carriage.

4. Hit the screen 2 feet 4 inches from the ground; 1 of the gun detachment struck; 2 hits on gun carriage.

The screens were removed and the firing carried on at the guns.

5. Grazed 33 yards in front of the gun; 1 hit on gun carriage.
6. Grazed 24 yards in front of the gun; 1 of the gun detachment hit.
7. Grazed 10 yards in front of the gun; 5 of the gun detachment hit; 8 hits on the gun carriage.
8. Grazed 21 yards in front of the gun; 2 of the gun detachment hit.
9. Grazed 17 yards in front of the gun; 7 of the gun detachment hit; 3 hits on the carriage.

### SEGMENT SHELL.

Percussion fuses used throughout.

#### EFFECT AGAINST ROPE MANTLETS.

*June 3, 1864.*

RANGE, 400 yards.

The mantlets consisted of four plies of 4-inch rope frapped together with spun yarn in the usual manner.

A screen 2 inches thick was placed 23 yards in front of the mantlets, to burst the 3 first rounds of shell.

Two 9-foot targets 6 yards in rear of the mantlets.

No. 1. Burst 15 yards in front of mantlet.

Six hits on mantlet.

Nil through the mantlet.

Nil hits on target.

No. 2. Burst 15 yards in front of mantlet.

One hit on mantlet.

Nil through the mantlet.

Nil hits on target.

No. 3. Burst 8 yards in front of mantlet.

Two hits on mantlet.

One through the mantlet.

Nil hits on target.

No. 4. Passed through the mantlet, the screen having been removed; burst while passing through; hit full on the face of the gun. No hits on target.

No. 5. Passed through top of mantlet and burst on passing. 82 hits on target.

No. 6. Passed through the mantlet and burst on passing. 88 hits on target.

DESTRUCTIVE EFFECT OF SEGMENT SHELL USED AS  
COMMON CASE.

Both Time and Percussion Fuzes used.

May 5, 1864.

RANGE, 450 yards. The target consisted of six lines of 2-inch deal boards, 9 × 54 feet front, five yards interval. Five rounds segment shells were fired.

| Line of Targets. | No. of Target. | Through. | Struck. |
|------------------|----------------|----------|---------|
| 1st Line -       | 1              | 1        | 1       |
|                  | 2              | 1        | 0       |
|                  | 3              | 1        | 0       |
|                  | 4              | 1        | 1       |
|                  | 5              | 2        | 0       |
|                  | 6              | 1        | 0       |
| 2nd Line         | 1              | 1        | 0       |
|                  | 2              | 2        | 0*      |
|                  | 3              | 5        | 5       |
|                  | 4              | 31       | 9†      |
|                  | 5              | 3        | 2       |
|                  | 6              | 0        | 1       |
| 3rd Line -       | 1              | 0        | 2       |
|                  | 2              | 26       | 17      |
|                  | 3              | 46       | 35      |
|                  | 4              | 62       | 18‡     |
|                  | 5              | 23       | 24§     |
|                  | 6              | 2        | 8       |
| 4th Line -       | 1              | 0        | 0       |
|                  | 2              | 4        | 15      |
|                  | 3              | 12       | 18      |
|                  | 4              | 41       | 45      |
|                  | 5              | 22       | 46      |
|                  | 6              | 38       | 49      |
| 5th Line -       | 1              | 0        | 0       |
|                  | 2              | 0        | 3       |
|                  | 3              | 1        | 5       |
|                  | 4              | 6        | 20      |
|                  | 5              | 1        | 18      |
|                  | 6              | 4        | 21      |
| 6th Line -       | 1              | 0        | 0       |
|                  | 2              | 0        | 0       |
|                  | 3              | 1        | 3       |
|                  | 4              | 0        | 0       |
|                  | 5              | 0        | 0       |
|                  | 6              | 0        | 2       |

\* Ragged hole 20 × 15 inches.  
† Ragged hole 11 × 5 inches.  
‡ Ragged hole 24 × 4 inches.  
§ Ragged hole 26 × 12 inches.

May 6, 1864.

RANGE, 450 yards. Five rounds against the same six lines of targets.

The record taken of the number of men that would have been struck had the lines of targets been replaced by men.

|          |   |   |        |
|----------|---|---|--------|
| 1st line | - | - | 5 men. |
| 2nd line | - | - | 7 "    |
| 3rd line | - | - | 27 "   |
| 4th line | - | - | 31 "   |
| 5th line | - | - | 30 "   |
| 6th line | - | - | 18 "   |

RANGE, 300 yards. At single line of targets, 72 feet face to represent men.

|          |   |         |
|----------|---|---------|
| 2 rounds | - | 19 men. |
| 3 "      | - | 12 "    |

RANGE, 200 yards. At the same targets.

|          |   |         |
|----------|---|---------|
| 2 rounds | - | 11 men. |
| 3 "      | - | 18 "    |

RANGE, 100 yards. At same targets,

|          |   |        |
|----------|---|--------|
| 2 rounds | - | 9 men. |
| 3 "      | - | 8 "    |

RANGE, 50 yards. At same targets.

|          |   |        |
|----------|---|--------|
| 2 rounds | - | 2 men. |
| 3 "      | - | 2 "    |



(LIEUT. REEVES') COMMON CASE.

October 17, 1864.

The target consisted of 2-inch deal ; area, 54 × 9 feet.

| RANGE, 350 yards. |          |         |         | RANGE, 250 yards. |          |         |         |
|-------------------|----------|---------|---------|-------------------|----------|---------|---------|
| —                 | Through. | Lodged. | Struck. | —                 | Through. | Lodged. | Struck. |
| 1st Round.        |          |         |         | 1st Round.        |          |         |         |
| 1 target - -      | 0        | 0       | 0       | 1 target - -      | 0        | 0       | 0       |
| 2 " - -           | 0        | 0       | 0       | 2 " - -           | 4        | 0       | 0       |
| 3 " - -           | 1        | 0       | 0       | 3 " - -           | 0        | 1       | 0       |
| 4 " - -           | 1        | 0       | 0       | 4 " - -           | 1        | 0       | 0       |
| 5 " - -           | 2        | 3       | 0       | 5 " - -           | 1        | 0       | 0       |
| 6 " - -           | 0        | 0       | 0       | 6 " - -           | 1        | 0       | 0       |
| 2nd Round.        |          |         |         | 2nd Round.        |          |         |         |
| 1 target - -      | 0        | 1       | 0       | 1 target - -      | 3        | 0       | 0       |
| 2 " - -           | 1        | 0       | 0       | 2 " - -           | 1        | 0       | 0       |
| 3 " - -           | 2        | 0       | 0       | 3 " - -           | 4        | 0       | 0       |
| 4 " - -           | 0        | 0       | 0       | 4 " - -           | 2        | 0       | 0       |
| 5 " - -           | 1        | 0       | 0       | 5 " - -           | 2        | 0       | 0       |
| 6 " - -           | 2        | 0       | 1       | 6 " - -           | 5        | 0       | 0       |
| 3rd Round.        |          |         |         | 3rd Round.        |          |         |         |
| 1 target - -      | 1        | 0       | 1       | 1 target - -      | 1        | 0       | 0       |
| 2 " - -           | 1        | 0       | 1       | 2 " - -           | 1        | 0       | 0       |
| 3 " - -           | 0        | 0       | 0       | 3 " - -           | 2        | 0       | 0       |
| 4 " - -           | 0        | 0       | 0       | 4 " - -           | 2        | 0       | 0       |
| 5 " - -           | 0        | 0       | 1       | 5 " - -           | 3        | 0       | 0       |
| 6 " - -           | 1        | 1       | 0       | 6 " - -           | 1        | 0       | 0       |
| 4th Round.        |          |         |         | 4th Round.        |          |         |         |
| 1 target - -      | 0        | 0       | 1       | 1 target - -      | 0        | 0       | 1       |
| 2 " - -           | 2        | 0       | 0       | 2 " - -           | 4        | 0       | 0       |
| 3 " - -           | 0        | 0       | 0       | 3 " - -           | 3        | 0       | 0       |
| 4 " - -           | 0        | 1       | 2       | 4 " - -           | 2        | 0       | 0       |
| 5 " - -           | 3        | 0       | 0       | 5 " - -           | 8        | 0       | 0       |
| 6 " - -           | 0        | 0       | 0       | 6 " - -           | 0        | 0       | 0       |
| 5th Round.        |          |         |         | 5th Round.        |          |         |         |
| 1 target - -      | 2        | 0       | 0       | 1 target - -      | 0        | 0       | 0       |
| 2 " - -           | 0        | 0       | 0       | 2 " - -           | 0        | 0       | 0       |
| 3 " - -           | 0        | 0       | 1       | 3 " - -           | 2        | 0       | 0       |
| 4 " - -           | 0        | 1       | 0       | 4 " - -           | 3        | 0       | 0       |
| 5 " - -           | 0        | 0       | 1       | 5 " - -           | 3        | 0       | 0       |
| 6 " - -           | 2        | 1       | 3       | 6 " - -           | 2        | 0       | 0       |

(LIEUT. REEVES') COMMON CASE—*continued.*

RANGE, 200 yards.

RANGE, 150 yards.

| RANGE, 200 yards. |          |         |         | RANGE, 150 yards. |          |         |         |
|-------------------|----------|---------|---------|-------------------|----------|---------|---------|
| —                 | Through. | Lodged. | Struck. | —                 | Through. | Lodged. | Struck. |
| 1st Round.        |          |         |         | 1st Round.        |          |         |         |
| 1 target -        | 1        | 0       | 0       | 1 target -        | 2        | 2       | 0       |
| 2 " -             | 0        | 0       | 0       | 2 " -             | 6        | 0       | 0       |
| 3 " -             | 9        | 0       | 1       | 3 " -             | 3        | 0       | 0       |
| 4 " -             | 6        | 0       | 0       | 4 " -             | 11       | 0       | 0       |
| 5 " -             | 3        | 0       | 1       | 5 " -             | 8        | 0       | 0       |
| 6 " -             | 3        | 0       | 1       | 6 " -             | 5        | 0       | 0       |
| 2nd Round.        |          |         |         | 2nd Round.        |          |         |         |
| 1 target -        | 2        | 0       | 0       | 1 target -        | 4        | 0       | 0       |
| 2 " -             | 2        | 0       | 0       | 2 " -             | 1        | 0       | 0       |
| 3 " -             | 8        | 0       | 0       | 3 " -             | 3        | 0       | 0       |
| 4 " -             | 4        | 0       | 0       | 4 " -             | 9        | 0       | 0       |
| 5 " -             | 1        | 0       | 0       | 5 " -             | 7        | 0       | 0       |
| 6 " -             | 0        | 0       | 0       | 6 " -             | 3        | 0       | 0       |
| 3rd Round.        |          |         |         | 3rd Round.        |          |         |         |
| 1 target -        | 3        | 0       | 0       | 1 target -        | 3        | 0       | 0       |
| 2 " -             | 0        | 0       | 1       | 2 " -             | 3        | 0       | 0       |
| 3 " -             | 0        | 0       | 0       | 3 " -             | 7        | 0       | 0       |
| 4 " -             | 5        | 0       | 0       | 4 " -             | 7        | 0       | 0       |
| 5 " -             | 3        | 0       | 0       | 5 " -             | 8        | 1       | 0       |
| 6 " -             | 6        | 0       | 0       | 6 " -             | 4        | 0       | 0       |
| 4th Round.        |          |         |         | 4th Round.        |          |         |         |
| 1 target -        | 0        | 0       | 0       | 1 target -        | 3        | 0       | 1       |
| 2 " -             | 6        | 0       | 0       | 2 " -             | 4        | 0       | 0       |
| 3 " -             | 5        | 0       | 0       | 3 " -             | 8        | 1       | 0       |
| 4 " -             | 11       | 0       | 0       | 4 " -             | 11       | 1       | 0       |
| 5 " -             | 1        | 0       | 0       | 5 " -             | 2        | 0       | 0       |
| 6 " -             | 1        | 0       | 0       | 6 " -             | 5        | 0       | 0       |
| 5th Round.        |          |         |         | 5th Round.        |          |         |         |
| 1 target -        | 0        | 0       | 0       | 1 target -        | 2        | 0       | 0       |
| 2 " -             | 3        | 0       | 0       | 2 " -             | 1        | 0       | 0       |
| 3 " -             | 5        | 0       | 1       | 3 " -             | 1        | 0       | 0       |
| 4 " -             | 3        | 0       | 0       | 4 " -             | 4        | 0       | 0       |
| 5 " -             | 1        | 0       | 0       | 5 " -             | 6        | 0       | 0       |
| 6 " -             | 4        | 1       | 0       | 6 " -             | 4        | 0       | 0       |

RANGE, 50 yards.

| —          | Through. | Lodged. | Struck. |
|------------|----------|---------|---------|
| 1st Round. |          |         |         |
| 1 target - | 0        | 0       | 0       |
| 2 " -      | 0        | 0       | 0       |
| 3 " -      | 14       | 0       | 0       |
| 4 " -      | 37       | 0       | 0       |
| 5 " -      | 7        | 0       | 0       |
| 6 " -      | 0        | 0       | 0       |
| 2nd Round. |          |         |         |
| 1 target - | 0        | 0       | 0       |
| 2 " -      | 10       | 0       | 0       |
| 3 " -      | 64       | 0       | 0       |
| 4 " -      | 0        | 0       | 0       |
| 5 " -      | 0        | 0       | 0       |
| 6 " -      | 0        | 0       | 0       |
| 3rd Round. |          |         |         |
| 1 target - | 0        | 0       | 0       |
| 2 " -      | 0        | 0       | 0       |
| 3 " -      | 0        | 0       | 0       |
| 4 " -      | 27       | 0       | 0       |
| 5 " -      | 34       | 0       | 0       |
| 6 " -      | 1        | 0       | 0       |
| 4th Round. |          |         |         |
| 1 target - | 0        | 0       | 0       |
| 2 " -      | 22       | 1       | 0       |
| 3 " -      | 25       | 0       | 0       |
| 4 " -      | 10       | 0       | 0       |
| 5 " -      | 0        | 0       | 0       |
| 6 " -      | 0        | 0       | 0       |
| 5th Round. |          |         |         |
| 1 target - | 0        | 0       | 0       |
| 2 " -      | 0        | 0       | 0       |
| 3 " -      | 6        | 0       | 0       |
| 4 " -      | 38       | 0       | 0       |
| 5 " -      | 11       | 0       | 0       |
| 6 " -      | 0        | 0       | 0       |



## DESTRUCTIVE EFFECT OF SEGMENT SHELL AGAINST TARGETS REPRESENTING TROOPS IN LINE AND COLUMN.

May 30, 31, 1864.

RANGE, 600 yards.

The shells were fired at screens 2 inches thick, placed so as to insure the shells bursting 25 yards in front of the targets.

The targets consisted of three 9-foot targets, 2 inches thick, placed in line.

The shells struck the screen from 3 to 6 feet above the ground.

The percussion fuze used throughout.

|                                         |          | Through. | Lodged. | Struck. |
|-----------------------------------------|----------|----------|---------|---------|
| Struck 5 ft. 4 in.<br>above the ground. | 1 target | 5        | 6       | 1       |
|                                         | 2 "      | 7        | 5       | 2       |
|                                         | 3 "      | 21       | 2       | 1       |
| Struck 3 ft. 7 in.<br>above the ground. | 1 target | 14       | 5       | 0       |
|                                         | 2 "      | 8        | 5       | 0       |
|                                         | 3 "      | 20       | 2       | 1       |
| Struck 5 ft. 4 in.<br>above the ground. | 1 target | 8        | 4       | 2       |
|                                         | 2 "      | 9        | 6       | 1       |
|                                         | 3 "      | 14       | 4       | 0       |
| Struck 5 ft. 9 in.<br>above the ground. | 1 target | 12       | 6       | 1       |
|                                         | 2 "      | 8        | 3       | 2       |
|                                         | 3 "      | 8        | 2       | 1       |
| Struck 4 ft. 3 in.<br>above the ground. | 1 target | 6        | 1       | 0       |
|                                         | 2 "      | 4        | 1       | 0       |
|                                         | 3 "      | 7        | 4       | 3       |

The shells struck the screen from the ground to 3 feet above.

| —                                       | —        | Through. | Lodged. | Struck. |
|-----------------------------------------|----------|----------|---------|---------|
| Struck 2 ft. 8 in.<br>above the ground. | 1 target | 1        | 2       | 1       |
|                                         | 2 "      | 8        | 7       | 1       |
|                                         | 3 "      | 13.      | 2       | 0       |
| Struck 16 in. above<br>the ground.      | 1 target | 18       | 5       | 5       |
|                                         | 2 "      | 8        | 5       | 4       |
|                                         | 3 "      | 7        | 0       | 0       |
| Struck 11 in. above<br>the ground.      | 1 target | 13       | 3       | 1       |
|                                         | 2 "      | 3        | 0       | 0       |
|                                         | 3 "      | 5        | 2       | 5       |
| Struck 2 ft. above<br>the ground.       | 1 target | 4        | 1       | 0       |
|                                         | 2 "      | 9        | 3       | 0       |
|                                         | 3 "      | 4        | 3       | 2       |
| Struck 2 ft. 9 in.<br>above the ground. | 1 target | 19       | 3       | 2       |
|                                         | 2 "      | 16       | 3       | 4       |
|                                         | 3 "      | 22       | 2       | 2       |

The screen was placed so that the shell should burst 50 yards in front of the targets.

The shell struck from 4 to 7 feet above the ground.

|                                          |          | Through. | Lodged. | Struck. |
|------------------------------------------|----------|----------|---------|---------|
| Struck 4 ft. 6 in.<br>above the ground.  | 1 target | 5        | 0       | 2       |
|                                          | 2 "      | 4        | 0       | 0       |
|                                          | 3 "      | 3        | 2       | 0       |
| Struck 4 ft. 10 in.<br>above the ground. | 1 target | 1        | 0       | 0       |
|                                          | 2 "      | 1        | 0       | 1       |
|                                          | 3 "      | 4        | 2       | 0       |
| Struck 4 ft. above<br>the ground.        | 1 target | 2        | 0       | 0       |
|                                          | 2 "      | 4        | 3       | 0       |
|                                          | 3 "      | 0        | 0       | 0       |
| Struck 4 ft. above<br>the ground.        | 1 target | 7        | 0       | 0       |
|                                          | 2 "      | 0        | 0       | 2       |
|                                          | 3 "      | 0        | 2       | 3       |
| Struck 4 ft. 6 in.<br>above the ground.  | 1 target | 2        | 0       | 0       |
|                                          | 2 "      | 2        | 0       | 0       |
|                                          | 3 "      | 0        | 5       | 0       |
|                                          | 4 "      | 2        | 1       | 1       |
|                                          | 5 "      | 1        | 0       | 0       |
|                                          | 6 "      | 2        | 0       | 1       |

The shell struck from 4 feet to the ground.

|                                         |          | Through. | Lodged. | Struck. |
|-----------------------------------------|----------|----------|---------|---------|
| Struck 3 ft. 7 in.<br>above the ground. | 1 target | 6        | 2       | 0       |
|                                         | 2 "      | 1        | 0       | 0       |
|                                         | 3 "      | 5        | 0       | 0       |
| Struck 2 ft. 9 in.<br>above the ground. | 1 target | 4        | 0       | 0       |
|                                         | 2 "      | 0        | 3       | 2       |
|                                         | 3 "      | 2        | 0       | 1       |
| Struck 4 ft. 0 in.<br>above the ground. | 1 target | 0        | 0       | 0       |
|                                         | 2 "      | 0        | 0       | 0       |
|                                         | 3 "      | 4        | 2       | 1       |
|                                         | 4 "      | 2        | 1       | 2       |
|                                         | 5 "      | 3        | 0       | 0       |
|                                         | 6 "      | 2        | 3       | 2       |
| Struck 2 ft. 3 in.<br>above the ground. | 1 target | 8        | 0       | 1       |
|                                         | 2 "      | 0        | 2       | 0       |
|                                         | 3 "      | 2        | 0       | 1       |
|                                         | 4 "      | 2        | 1       | 2       |
|                                         | 5 "      | 1        | 0       | 2       |
|                                         | 6 "      | 2        | 0       | 0       |
| Struck 1 ft. 9 in.<br>above the ground. | 1 target | 1        | 0       | 0       |
|                                         | 2 "      | 2        | 0       | 0       |
|                                         | 3 "      | 0        | 0       | 2       |
|                                         | 4 "      | 1        | 2       | 1       |
|                                         | 5 "      | 3        | 0       | 0       |
|                                         | 6 "      | 0        | 0       | 1       |

## SEGMENT SHELL.

June 1, 1864.

RANGE, 600 yards.

The shells fired at a screen placed so as to burst them 100 yards in front of targets.

The shells struck the screen from 10 to 7 feet from the ground.

The shells struck the screen from 7 feet to the ground.

|                                         |          | Through. | Lodged. | Struck. |                                          |          | Through. | Lodged. | Struck. |
|-----------------------------------------|----------|----------|---------|---------|------------------------------------------|----------|----------|---------|---------|
| Struck 9 ft. 8 in.<br>above the ground. | 1 target | 1        | 0       | 0       | Struck 4 ft. 10 in.<br>above the ground. | 1 target | 0        | 1       | 0       |
|                                         | 2 "      | 0        | 0       | 2       |                                          | 2 "      | 0        | 0       | 1       |
|                                         | 3 "      | 0        | 0       | 0       |                                          | 3 "      | 0        | 0       | 0       |
|                                         | 4 "      | 1        | 1       | 0       |                                          | 4 "      | 0        | 2       | 0       |
|                                         | 5 "      | 2        | 2       | 0       |                                          | 5 "      | 0        | 1       | 2       |
|                                         | 6 "      | 2        | 0       | 1       |                                          | 6 "      | 0        | 1       | 2       |
|                                         | 7 "      | 0        | 1       | 1       |                                          | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 1        | 1       | 3       |                                          | 8 "      | 0        | 0       | 0       |
| Struck 8 ft. above<br>the ground.       | 1 target | 0        | 0       | 1       | Struck 5 ft. 11 in.<br>above the ground. | 1 target | 2        | 0       | 0       |
|                                         | 2 "      | 0        | 0       | 0       |                                          | 2 "      | 2        | 1       | 1       |
|                                         | 3 "      | 0        | 0       | 0       |                                          | 3 "      | 0        | 2       | 0       |
|                                         | 4 "      | 1        | 0       | 3       |                                          | 4 "      | 2        | 1       | 0       |
|                                         | 5 "      | 0        | 1       | 0       |                                          | 5 "      | 0        | 0       | 2       |
|                                         | 6 "      | 0        | 0       | 0       |                                          | 6 "      | 0        | 1       | 0       |
|                                         | 7 "      | 0        | 0       | 1       |                                          | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 0        | 0       | 0       |                                          | 8 "      | 0        | 0       | 0       |
| Struck 9 ft. 6 in.<br>above the ground. | 1 target | 0        | 0       | 1       | Struck 6 ft. 7 in.<br>above the ground.  | 1 target | 0        | 1       | 0       |
|                                         | 2 "      | 0        | 1       | 0       |                                          | 2 "      | 3        | 0       | 0       |
|                                         | 3 "      | 0        | 0       | 1       |                                          | 3 "      | 0        | 0       | 0       |
|                                         | 4 "      | 0        | 0       | 0       |                                          | 4 "      | 1        | 0       | 0       |
|                                         | 5 "      | 2        | 0       | 2       |                                          | 5 "      | 0        | 1       | 0       |
|                                         | 6 "      | 0        | 1       | 0       |                                          | 6 "      | 0        | 1       | 1       |
|                                         | 7 "      | 0        | 1       | 0       |                                          | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 0        | 1       | 0       |                                          | 8 "      | 0        | 0       | 0       |
| Struck 7 ft. 8 in.<br>above the ground. | 1 target | 1        | 1       | 1       | Struck 6 ft. 1 in.<br>above the ground.  | 1 target | 0        | 1       | 0       |
|                                         | 2 "      | 0        | 0       | 0       |                                          | 2 "      | 1        | 0       | 0       |
|                                         | 3 "      | 0        | 0       | 4       |                                          | 3 "      | 0        | 0       | 0       |
|                                         | 4 "      | 0        | 0       | 0       |                                          | 4 "      | 1        | 0       | 2       |
|                                         | 5 "      | 0        | 2       | 0       |                                          | 5 "      | 2        | 1       | 0       |
|                                         | 6 "      | 2        | 0       | 1       |                                          | 6 "      | 0        | 0       | 0       |
|                                         | 7 "      | 0        | 0       | 0       |                                          | 7 "      | 0        | 0       | 1       |
|                                         | 8 "      | 0        | 0       | 2       |                                          | 8 "      | 0        | 1       | 0       |
| Struck 7 ft. 8 in.<br>above the ground. | 1 target | 2        | 0       | 1       | Struck 2 ft. above<br>the ground.        | 1 target | 1        | 2       | 0       |
|                                         | 2 "      | 0        | 0       | 4       |                                          | 2 "      | 1        | 2       | 0       |
|                                         | 3 "      | 0        | 0       | 2       |                                          | 3 "      | 0        | 0       | 0       |
|                                         | 4 "      | 0        | 1       | 0       |                                          | 4 "      | 1        | 1       | 0       |
|                                         | 5 "      | 1        | 0       | 1       |                                          | 5 "      | 0        | 2       | 1       |
|                                         | 6 "      | 0        | 1       | 1       |                                          | 6 "      | 1        | 0       | 2       |
|                                         | 7 "      | 0        | 0       | 0       |                                          | 7 "      | 0        | 1       | 1       |
|                                         | 8 "      | 0        | 0       | 0       |                                          | 8 "      | 0        | 0       | 0       |



SEGMENT SHELL—*continued.*

June 9, 1864.

RANGE, 800 yards.

The screen was placed at 18 yards in front of the target, to insure the shell bursting 10 yards in front of the target.

From ground to 5 feet.

From 5 to 8½ feet.

|                                         |          | Through. | Lodged. | Struck. |                                         |          | Through. | Lodged. | Struck. |
|-----------------------------------------|----------|----------|---------|---------|-----------------------------------------|----------|----------|---------|---------|
| Struck 4 ft. 6 in.<br>above the ground. | 1 target | 0        | 0       | 0       | Struck 5 ft. 7 in.<br>above the ground. | 1 target | 0        | 0       | 0       |
|                                         | 2 "      | 0        | 0       | 0       |                                         | 2 "      | 0        | 0       | 0       |
|                                         | 3 "      | 0        | 1       | 0       |                                         | 3 "      | 15       | 3       | 1       |
|                                         | 4 "      | 31       | 3       | 2       |                                         | 4 "      | 19       | 18      | 6       |
|                                         | 5 "      | 36       | 7       | 3       |                                         | 5 "      | 18       | 0       | 4       |
|                                         | 6 "      | 0        | 0       | 0       |                                         | 6 "      | 0        | 0       | 0       |
|                                         | 7 "      | 0        | 0       | 0       |                                         | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 0        | 0       | 0       |                                         | 8 "      | 0        | 0       | 0       |
| Struck 4 ft. 3 in.<br>above the ground. | 1 target | 0        | 0       | 0       | Struck 6 ft. above<br>the ground.       | 1 target | 0        | 0       | 0       |
|                                         | 2 "      | 0        | 0       | 0       |                                         | 2 "      | 0        | 0       | 0       |
|                                         | 3 "      | 0        | 0       | 1       |                                         | 3 "      | 1        | 1       | 1       |
|                                         | 4 "      | 25       | 6       | 2       |                                         | 4 "      | 28       | 1       | 1       |
|                                         | 5 "      | 30       | 7       | 12      |                                         | 5 "      | 27       | 1       | 1       |
|                                         | 6 "      | 1        | 0       | 0       |                                         | 6 "      | 0        | 0       | 0       |
|                                         | 7 "      | 0        | 0       | 0       |                                         | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 0        | 0       | 0       |                                         | 8 "      | 0        | 0       | 0       |
| Struck 2 ft. 9 in.<br>above the ground. | 1 target | 0        | 0       | 0       | Struck 8 ft. 4 in.<br>above the ground. | 1 target | 0        | 0       | 0       |
|                                         | 2 "      | 0        | 0       | 0       |                                         | 2 "      | 0        | 0       | 0       |
|                                         | 3 "      | 15       | 6       | 0       |                                         | 3 "      | 0        | 1       | 0       |
|                                         | 4 "      | 26       | 5       | 4       |                                         | 4 "      | 20       | 5       | 1       |
|                                         | 5 "      | 12       | 5       | 7       |                                         | 5 "      | 15       | 1       | 3       |
|                                         | 6 "      | 0        | 0       | 0       |                                         | 6 "      | 0        | 1       | 0       |
|                                         | 7 "      | 0        | 0       | 0       |                                         | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 0        | 0       | 0       |                                         | 8 "      | 0        | 0       | 0       |
| Struck 4 ft. 9 in.<br>above the ground. | 1 target | 0        | 0       | 0       | Struck 6 ft. 7 in.<br>above the ground. | 1 target | 0        | 0       | 0       |
|                                         | 2 "      | 0        | 0       | 0       |                                         | 2 "      | 0        | 0       | 0       |
|                                         | 3 "      | 0        | 1       | 0       |                                         | 3 "      | 0        | 0       | 0       |
|                                         | 4 "      | 27       | 7       | 4       |                                         | 4 "      | 22       | 12      | 6       |
|                                         | 5 "      | 11       | 3       | 9       |                                         | 5 "      | 19       | 6       | 2       |
|                                         | 6 "      | 0        | 0       | 0       |                                         | 6 "      | 0        | 0       | 0       |
|                                         | 7 "      | 0        | 0       | 0       |                                         | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 0        | 0       | 0       |                                         | 8 "      | 0        | 0       | 0       |
| Struck 3 ft. 4 in.<br>above the ground. | 1 target | 0        | 0       | 0       | Struck 5 ft. 9 in.<br>above the ground. | 1 target | 1        | 0       | 0       |
|                                         | 2 "      | 0        | 0       | 0       |                                         | 2 "      | 0        | 0       | 0       |
|                                         | 3 "      | 4        | 2       | 0       |                                         | 3 "      | 26       | 4       | 10      |
|                                         | 4 "      | 21       | 9       | 5       |                                         | 4 "      | 46       | 3       | 13      |
|                                         | 5 "      | 9        | 6       | 10      |                                         | 5 "      | 0        | 0       | 0       |
|                                         | 6 "      | 0        | 0       | 0       |                                         | 6 "      | 0        | 0       | 0       |
|                                         | 7 "      | 0        | 0       | 0       |                                         | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 0        | 0       | 0       |                                         | 8 "      | 0        | 0       | 0       |

SEGMENT SHELL—continued.

June 10, 1864.

RANGE. 800 yards.

The shell to burst 25 yards in front of the targets.

The shell to strike the screen from 5 to 9 feet.

Shell to strike the screen from the ground to 5 feet.

|                                         |          | Through. | Lodged. | Struck. |                                          |          | Through. | Lodged. | Struck. |
|-----------------------------------------|----------|----------|---------|---------|------------------------------------------|----------|----------|---------|---------|
| Struck 7 ft. 3 in.<br>above the ground. | 1 target | 0        | 0       | 0       | Struck 4 ft. 7 ins.<br>above the ground. | 1 target | 0        | 0       | 1       |
|                                         | 2 "      | 0        | 0       | 0       |                                          | 2 "      | 0        | 0       | 0       |
|                                         | 3 "      | 4        | 1       | 1       |                                          | 3 "      | 14       | 2       | 0       |
|                                         | 4 "      | 10       | 2       | 2       |                                          | 4 "      | 11       | 2       | 2       |
|                                         | 5 "      | 8        | 3       | 0       |                                          | 5 "      | 7        | 0       | 0       |
|                                         | 6 "      | 7        | 2       | 0       |                                          | 6 "      | 6        | 3       | 0       |
|                                         | 7 "      | 4        | 0       | 0       |                                          | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 0        | 0       | 0       |                                          | 8 "      | 0        | 0       | 0       |
| Struck 7 ft. 5 in.<br>above the ground. | 1 target | 0        | 0       | 0       | Struck 3 ft. 8 in.<br>above the ground.  | 1 target | 0        | 0       | 0       |
|                                         | 2 "      | 0        | 2       | 0       |                                          | 2 "      | 0        | 0       | 0       |
|                                         | 3 "      | 12       | 2       | 2       |                                          | 3 "      | 8        | 2       | 0       |
|                                         | 4 "      | 5        | 5       | 3       |                                          | 4 "      | 4        | 4       | 0       |
|                                         | 5 "      | 5        | 4       | 1       |                                          | 5 "      | 10       | 1       | 2       |
|                                         | 6 "      | 12       | 1       | 1       |                                          | 6 "      | 19       | 1       | 3       |
|                                         | 7 "      | 0        | 0       | 0       |                                          | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 0        | 0       | 0       |                                          | 8 "      | 0        | 0       | 1       |
| Struck 7 ft. above<br>the ground.       | 1 target | 0        | 0       | 0       | Struck 2 ft. 4 in.<br>above the ground.  | 1 target | 0        | 0       | 0       |
|                                         | 2 "      | 0        | 0       | 0       |                                          | 2 "      | 2        | 3       | 1       |
|                                         | 3 "      | 0        | 0       | 0       |                                          | 3 "      | 8        | 3       | 0       |
|                                         | 4 "      | 21       | 3       | 5       |                                          | 4 "      | 5        | 6       | 0       |
|                                         | 5 "      | 9        | 5       | 1       |                                          | 5 "      | 12       | 2       | 3       |
|                                         | 6 "      | 5        | 0       | 2       |                                          | 6 "      | 7        | 3       | 4       |
|                                         | 7 "      | 6        | 0       | 0       |                                          | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 0        | 0       | 0       |                                          | 8 "      | 0        | 0       | 0       |
| Struck 6 ft. 3 in.<br>above the ground. | 1 target | 0        | 0       | 0       | Struck 4 ft. 2 in.<br>above the ground.  | 1 target | 0        | 0       | 0       |
|                                         | 2 "      | 0        | 0       | 0       |                                          | 2 "      | 0        | 0       | 1       |
|                                         | 3 "      | 5        | 3       | 1       |                                          | 3 "      | 8        | 1       | 1       |
|                                         | 4 "      | 9        | 4       | 2       |                                          | 4 "      | 9        | 4       | 3       |
|                                         | 5 "      | 13       | 1       | 3       |                                          | 5 "      | 8        | 2       | 2       |
|                                         | 6 "      | 9        | 3       | 2       |                                          | 6 "      | 9        | 1       | 0       |
|                                         | 7 "      | 0        | 0       | 0       |                                          | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 0        | 0       | 0       |                                          | 8 "      | 0        | 0       | 0       |
| Struck 5 ft. above<br>the ground.       | 1 target | 0        | 0       | 0       | Struck 2 ft. 4 in.<br>above the ground.  | 1 target | 0        | 1       | 0       |
|                                         | 2 "      | 7        | 1       | 1       |                                          | 2 "      | 6        | 0       | 0       |
|                                         | 3 "      | 1        | 1       | 1       |                                          | 3 "      | 6        | 0       | 2       |
|                                         | 4 "      | 9        | 1       | 1       |                                          | 4 "      | 11       | 3       | 0       |
|                                         | 5 "      | 10       | 4       | 1       |                                          | 5 "      | 12       | 6       | 3       |
|                                         | 6 "      | 5        | 0       | 2       |                                          | 6 "      | 8        | 2       | 3       |
|                                         | 7 "      | 0        | 0       | 0       |                                          | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 0        | 0       | 0       |                                          | 8 "      | 0        | 0       | 0       |



SEGMENT SHELL—*continued*.

June 13, 1864.]

RANGE, 800 yards.

The shells were burst 50 yards in front of the targets.

The shell to strike the screen from 6 to 10 feet from the ground.

From the ground to 6 feet.

| —                                    | —        | Through. | Lodged. | Struck. | —                                    | —        | Through. | Lodged. | Struck. |
|--------------------------------------|----------|----------|---------|---------|--------------------------------------|----------|----------|---------|---------|
| Struck 7 ft. 4 in. above the ground. | 1 target | 1        | 0       | 0       | Struck 5 ft. 3 in. above the ground. | 1 target | 1        | 2       | 1       |
|                                      | 2 "      | 9        | 0       | 0       |                                      | 2 "      | 2        | 3       | 0       |
|                                      | 3 "      | 2        | 1       | 0       |                                      | 3 "      | 3        | 4       | 0       |
|                                      | 4 "      | 4        | 2       | 0       |                                      | 4 "      | 3        | 2       | 1       |
|                                      | 5 "      | 2        | 2       | 0       |                                      | 5 "      | 1        | 1       | 0       |
|                                      | 6 "      | 0        | 0       | 1       |                                      | 6 "      | 1        | 2       | 0       |
|                                      | 7 "      | 3        | 1       | 0       |                                      | 7 "      | 4        | 0       | 0       |
|                                      | 8 "      | 5        | 2       | 1       |                                      | 8 "      | 3        | 0       | 1       |
| Struck 9 ft. 5 in. above the ground. | 1 target | 0        | 1       | 0       | Struck 5 ft. 2 in. above the ground. | 1 target | 3        | 0       | 0       |
|                                      | 2 "      | 7        | 2       | 0       |                                      | 2 "      | 10       | 2       | 1       |
|                                      | 3 "      | 3        | 1       | 1       |                                      | 3 "      | 2        | 5       | 1       |
|                                      | 4 "      | 1        | 0       | 0       |                                      | 4 "      | 2        | 4       | 0       |
|                                      | 5 "      | 4        | 2       | 2       |                                      | 5 "      | 2        | 0       | 0       |
|                                      | 6 "      | 2        | 1       | 0       |                                      | 6 "      | 3        | 2       | 0       |
|                                      | 7 "      | 5        | 3       | 1       |                                      | 7 "      | 2        | 1       | 0       |
|                                      | 8 "      | 1        | 0       | 0       |                                      | 8 "      | 3        | 0       | 0       |
| Struck 6 ft. 6 in. above the ground. | 1 target | 0        | 0       | 0       | Struck 1 ft. 7 in. above the ground. | 1 target | 4        | 1       | 0       |
|                                      | 2 "      | 5        | 0       | 0       |                                      | 2 "      | 9        | 3       | 0       |
|                                      | 3 "      | 0        | 0       | 0       |                                      | 3 "      | 4        | 0       | 0       |
|                                      | 4 "      | 4        | 4       | 4       |                                      | 4 "      | 1        | 2       | 1       |
|                                      | 5 "      | 0        | 1       | 0       |                                      | 5 "      | 3        | 2       | 0       |
|                                      | 6 "      | 2        | 0       | 1       |                                      | 6 "      | 1        | 1       | 1       |
|                                      | 7 "      | 1        | 1       | 0       |                                      | 7 "      | 4        | 1       | 1       |
|                                      | 8 "      | 7        | 0       | 1       |                                      | 8 "      | 4        | 1       | 0       |
| Struck 6 ft. 6 in. above the ground. | 1 target | 1        | 0       | 2       | Struck 5 ft. above the ground.       | 1 target | 1        | 0       | 0       |
|                                      | 2 "      | 2        | 0       | 0       |                                      | 2 "      | 3        | 1       | 1       |
|                                      | 3 "      | 2        | 2       | 0       |                                      | 3 "      | 1        | 5       | 0       |
|                                      | 4 "      | 1        | 2       | 0       |                                      | 4 "      | 1        | 0       | 0       |
|                                      | 5 "      | 1        | 0       | 0       |                                      | 5 "      | 4        | 1       | 0       |
|                                      | 6 "      | 6        | 2       | 1       |                                      | 6 "      | 3        | 3       | 0       |
|                                      | 7 "      | 0        | 2       | 0       |                                      | 7 "      | 3        | 2       | 1       |
|                                      | 8 "      | 1        | 0       | 0       |                                      | 8 "      | 5        | 1       | 0       |
| Struck 6 ft. 9 in. above the ground. | 1 target | 0        | 1       | 1       | Struck 3 ft. above the ground.       | 1 target | 1        | 0       | 0       |
|                                      | 2 "      | 3        | 0       | 1       |                                      | 2 "      | 2        | 2       | 0       |
|                                      | 3 "      | 1        | 2       | 2       |                                      | 3 "      | 1        | 0       | 0       |
|                                      | 4 "      | 5        | 0       | 0       |                                      | 4 "      | 0        | 3       | 0       |
|                                      | 5 "      | 1        | 2       | 1       |                                      | 5 "      | 1        | 1       | 0       |
|                                      | 6 "      | 1        | 1       | 2       |                                      | 6 "      | 1        | 3       | 0       |
|                                      | 7 "      | 0        | 2       | 0       |                                      | 7 "      | 1        | 0       | 0       |
|                                      | 8 "      | 1        | 1       | 0       |                                      | 8 "      | 0        | 1       | 1       |

## SEGMENT SHELL—continued.

June 14, 1864.

RANGE, 800 yards.

The shell to burst 100 yards in front of the targets.

To strike the screen from 9 to 13 feet from the ground.

To strike the screen from 9 feet to the ground.

|                                          |          | Through. | Lodged. | Struck. |                                         |          | Through. | Lodged. | Struck. |
|------------------------------------------|----------|----------|---------|---------|-----------------------------------------|----------|----------|---------|---------|
| Struck 9 ft. 4 in.<br>above the ground.  | 1 target | 0        | 1       | 0       | Struck 7 ft. 7 in.<br>above the ground. | 1 target | 2        | 1       | 0       |
|                                          | 2 "      | 0        | 0       | 0       |                                         | 2 "      | 1        | 1       | 1       |
|                                          | 3 "      | 0        | 2       | 1       |                                         | 3 "      | 0        | 0       | 0       |
|                                          | 4 "      | 1        | 4       | 0       |                                         | 4 "      | 0        | 0       | 0       |
|                                          | 5 "      | 2        | 2       | 1       |                                         | 5 "      | 2        | 0       | 0       |
|                                          | 6 "      | 2        | 1       | 1       |                                         | 6 "      | 1        | 1       | 0       |
|                                          | 7 "      | 0        | 0       | 1       |                                         | 7 "      | 1        | 1       | 0       |
|                                          | 8 "      | 0        | 0       | 0       |                                         | 8 "      | 0        | 0       | 0       |
| Struck 10 ft. 1 in.<br>above the ground. | 1 target | 1        | 2       | 0       | Struck 8 ft. above<br>the ground.       | 1 target | 3        | 7       | 0       |
|                                          | 2 "      | 1        | 1       | 0       |                                         | 2 "      | 0        | 0       | 1       |
|                                          | 3 "      | 1        | 0       | 0       |                                         | 3 "      | 0        | 1       | 0       |
|                                          | 4 "      | 0        | 1       | 0       |                                         | 4 "      | 1        | 1       | 0       |
|                                          | 5 "      | 1        | 0       | 0       |                                         | 5 "      | 1        | 0       | 0       |
|                                          | 6 "      | 1        | 3       | 1       |                                         | 6 "      | 0        | 1       | 1       |
|                                          | 7 "      | 1        | 2       | 1       |                                         | 7 "      | 1        | 0       | 0       |
|                                          | 8 "      | 0        | 1       | 1       |                                         | 8 "      | 0        | 2       | 0       |
| Struck 11 ft. 3 in.<br>above the ground. | 1 target | 4        | 1       | 1       | Struck 5 ft. above<br>the ground.       | 1 target | 1        | 1       | 0       |
|                                          | 2 "      | 2        | 0       | 0       |                                         | 2 "      | 2        | 1       | 1       |
|                                          | 3 "      | 1        | 0       | 0       |                                         | 3 "      | 1        | 1       | 1       |
|                                          | 4 "      | 0        | 1       | 1       |                                         | 4 "      | 0        | 3       | 0       |
|                                          | 5 "      | 2        | 0       | 2       |                                         | 5 "      | 1        | 0       | 0       |
|                                          | 6 "      | 0        | 0       | 1       |                                         | 6 "      | 0        | 0       | 0       |
|                                          | 7 "      | 1        | 2       | 1       |                                         | 7 "      | 1        | 1       | 1       |
|                                          | 8 "      | 0        | 1       | 0       |                                         | 8 "      | 2        | 4       | 1       |
| Struck 11 ft. 4 in.<br>above the ground. | 1 target | 2        | 0       | 1       | Struck 5 ft. 6 in.<br>above the ground. | 1 target | 1        | 0       | 0       |
|                                          | 2 "      | 1        | 2       | 0       |                                         | 2 "      | 1        | 0       | 0       |
|                                          | 3 "      | 0        | 1       | 0       |                                         | 3 "      | 0        | 0       | 0       |
|                                          | 4 "      | 1        | 1       | 0       |                                         | 4 "      | 0        | 0       | 0       |
|                                          | 5 "      | 0        | 4       | 1       |                                         | 5 "      | 1        | 0       | 0       |
|                                          | 6 "      | 1        | 2       | 1       |                                         | 6 "      | 0        | 0       | 0       |
|                                          | 7 "      | 1        | 1       | 1       |                                         | 7 "      | 1        | 2       | 0       |
|                                          | 8 "      | 0        | 2       | 0       |                                         | 8 "      | 1        | 0       | 0       |
| Struck 9 ft. 8 in.<br>above the ground.  | 1 target | 1        | 1       | 0       | Struck 7 ft. 6 in.<br>above the ground. | 1 target | 0        | 1       | 0       |
|                                          | 2 "      | 1        | 1       | 1       |                                         | 2 "      | 0        | 0       | 0       |
|                                          | 3 "      | 2        | 2       | 0       |                                         | 3 "      | 0        | 1       | 1       |
|                                          | 4 "      | 0        | 0       | 0       |                                         | 4 "      | 1        | 0       | 0       |
|                                          | 5 "      | 1        | 2       | 0       |                                         | 5 "      | 1        | 1       | 1       |
|                                          | 6 "      | 3        | 3       | 1       |                                         | 6 "      | 0        | 0       | 1       |
|                                          | 7 "      | 0        | 1       | 1       |                                         | 7 "      | 0        | 0       | 0       |
|                                          | 8 "      | 1        | 2       | 0       |                                         | 8 "      | 0        | 6       | 0       |



## SEGMENT SHELL—continued.

June 29, 1864.

RANGE, 1,300 yards.

The target consisted of three lines of 9-foot targets, five in each line, 6 yards between the lines.  
The shell to burst 10 yards in front of the first line of targets.

To strike the screen from 5 feet to ground.

From 5 to 10 feet from the ground.

|                                         |           | Through. | Lodged. | Struck. |                                         |           | Through. | Lodged. | Struck. |
|-----------------------------------------|-----------|----------|---------|---------|-----------------------------------------|-----------|----------|---------|---------|
| Struck 2 ft. 9 in.<br>above the ground. | 1st line. |          |         |         | Struck 5 ft. 2 in.<br>above the ground. | 1st line. |          |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                         | 1 target  | 0        | 0       | 0       |
|                                         | 2 "       | 0        | 0       | 0       |                                         | 2 "       | 0        | 0       | 0       |
|                                         | 3 "       | 20       | 2       | 6       |                                         | 3 "       | 26       | 8       | 13      |
|                                         | 4 "       | 25       | 9       | 2       |                                         | 4 "       | 20       | 4       | 7       |
|                                         | 5 "       | 20       | 4       | 5       |                                         | 5 "       | 0        | 0       | 1       |
|                                         | 2nd line. |          |         |         |                                         | 2nd line. |          |         |         |
|                                         | 1 target  | 8        | 2       | 0       |                                         | 1 target  | 0        | 0       | 0       |
|                                         | 2 "       | 2        | 4       | 5       |                                         | 2 "       | 0        | 0       | 0       |
|                                         | 3 "       | 7        | 1       | 2       |                                         | 3 "       | 8        | 11      | 7       |
|                                         | 4 "       | 2        | 0       | 0       |                                         | 4 "       | 8        | 9       | 4       |
|                                         | 5 "       | 0        | 0       | 0       |                                         | 5 "       | 2        | 0       | 0       |
|                                         | 3rd line. |          |         |         |                                         | 3rd line. |          |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                         | 1 target  | 0        | 0       | 0       |
|                                         | 2 "       | 1        | 1       | 0       |                                         | 2 "       | 0        | 1       | 1       |
|                                         | 3 "       | 0        | 2       | 1       |                                         | 3 "       | 1        | 0       | 2       |
|                                         | 4 "       | 1        | 1       | 2       |                                         | 4 "       | 0        | 4       | 2       |
|                                         | 5 "       | 0        | 0       | 0       |                                         | 5 "       | 0        | 2       | 1       |
| Struck 3 ft. above<br>the ground.       | 1st line. |          |         |         | Struck 5 ft. 1 in.<br>above the ground. | 1st line. |          |         |         |
|                                         | 1 target  | 2        | 0       | 0       |                                         | 1 target  | 0        | 0       | 0       |
|                                         | 2 "       | 0        | 0       | 1       |                                         | 2 "       | 0        | 0       | 0       |
|                                         | 3 "       | 27       | 2       | 5       |                                         | 3 "       | 24       | 6       | 9       |
|                                         | 4 "       | 40       | 9       | 4       |                                         | 4 "       | 11       | 3       | 9       |
|                                         | 5 "       | 0        | 0       | 0       |                                         | 5 "       | 0        | 0       | 0       |
|                                         | 2nd line. |          |         |         |                                         | 2nd line. |          |         |         |
|                                         | 1 target  | 3        | 3       | 2       |                                         | 1 target  | 0        | 1       | 1       |
|                                         | 2 "       | 20       | 6       | 2       |                                         | 2 "       | 0        | 0       | 0       |
|                                         | 3 "       | 17       | 8       | 4       |                                         | 3 "       | 13       | 17      | 9       |
|                                         | 4 "       | 0        | 0       | 0       |                                         | 4 "       | 3        | 6       | 1       |
|                                         | 5 "       | 0        | 0       | 0       |                                         | 5 "       | 1        | 1       | 1       |
|                                         | 3rd line. |          |         |         |                                         | 3rd line. |          |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                         | 1 target  | 0        | 0       | 0       |
|                                         | 2 "       | 0        | 6       | 0       |                                         | 2 "       | 0        | 0       | 0       |
|                                         | 3 "       | 1        | 3       | 0       |                                         | 3 "       | 0        | 0       | 3       |
|                                         | 4 "       | 2        | 0       | 0       |                                         | 4 "       | 1        | 3       | 3       |
|                                         | 5 "       | 2        | 0       | 0       |                                         | 5 "       | 1        | 1       | 0       |
| Struck 4 ft. 4 in.<br>above the ground. | 1st line. |          |         |         | Struck 6 ft. above<br>the ground.       | 1st line. |          |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                         | 1 target  | 0        | 0       | 0       |
|                                         | 2 "       | 0        | 0       | 0       |                                         | 2 "       | 2        | 3       | 2       |
|                                         | 3 "       | 28       | 10      | 7       |                                         | 3 "       | 24       | 3       | 9       |
|                                         | 4 "       | 15       | 8       | 6       |                                         | 4 "       | 17       | 5       | 5       |
|                                         | 5 "       | 0        | 0       | 0       |                                         | 5 "       | 2        | 1       | 0       |
|                                         | 2nd line. |          |         |         |                                         | 2nd line. |          |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                         | 1 target  | 0        | 0       | 0       |
|                                         | 2 "       | 0        | 1       | 0       |                                         | 2 "       | 4        | 3       | 1       |
|                                         | 3 "       | 4        | 8       | 4       |                                         | 3 "       | 6        | 4       | 0       |
|                                         | 4 "       | 6        | 8       | 4       |                                         | 4 "       | 1        | 5       | 5       |
|                                         | 5 "       | 0        | 0       | 0       |                                         | 5 "       | 0        | 2       | 3       |
|                                         | 3rd line. |          |         |         |                                         | 3rd line. |          |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                         | 1 target  | 0        | 0       | 0       |
|                                         | 2 "       | 0        | 0       | 0       |                                         | 2 "       | 1        | 0       | 4       |
|                                         | 3 "       | 0        | 1       | 1       |                                         | 3 "       | 2        | 1       | 1       |
|                                         | 4 "       | 0        | 4       | 3       |                                         | 4 "       | 0        | 0       | 1       |
|                                         | 5 "       | 0        | 0       | 0       |                                         | 5 "       | 0        | 0       | 0       |

SEGMENT SHELL—*continued.*

September 8.

RANGE, 1,300 yards.

Shell to burst 100 yards in front of target, and to strike from 9 feet to the ground.

| —                                       | —         | Through. | Lodged. | Struck. | —                                        | —         | Through | Lodged. | Struck. |
|-----------------------------------------|-----------|----------|---------|---------|------------------------------------------|-----------|---------|---------|---------|
| Struck 2 ft. 6 in.<br>above the ground. | 1st line. |          |         |         | Struck 8 ft. 10 in.<br>above the ground. | 1st line. |         |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                          | 1 target  | 1       | 1       | 1       |
|                                         | 2 "       | 0        | 0       | 0       |                                          | 2 "       | 0       | 1       | 0       |
|                                         | 3 "       | 0        | 0       | 0       |                                          | 3 "       | 0       | 1       | 1       |
|                                         | 4 "       | 0        | 1       | 0       |                                          | 4 "       | 0       | 2       | 2       |
|                                         | 5 "       | 0        | 0       | 0       |                                          | 5 "       | 1       | 1       | 0       |
|                                         | 2nd line. |          |         |         |                                          | 2nd line. |         |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                          | 1 target  | 0       | 0       | 0       |
|                                         | 2 "       | 0        | 1       | 0       |                                          | 2 "       | 0       | 0       | 0       |
|                                         | 3 "       | 0        | 0       | 0       |                                          | 3 "       | 0       | 0       | 0       |
|                                         | 4 "       | 0        | 0       | 0       |                                          | 4 "       | 0       | 0       | 0       |
|                                         | 5 "       | 0        | 0       | 0       |                                          | 5 "       | 0       | 1       | 0       |
|                                         | 3rd line. |          |         |         |                                          | 3rd line. |         |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                          | 1 target  | 0       | 0       | 0       |
|                                         | 2 "       | 0        | 0       | 0       |                                          | 2 "       | 0       | 0       | 0       |
| Struck 1 ft. 6 in.<br>above the ground. | 3 "       | 0        | 0       | 0       | Struck 2 ft. 3 in.<br>above the ground.  | 3 "       | 0       | 0       | 0       |
|                                         | 4 "       | 0        | 0       | 0       |                                          | 4 "       | 0       | 0       | 0       |
|                                         | 5 "       | 0        | 0       | 0       |                                          | 5 "       | 0       | 0       | 0       |
|                                         | 1st line. |          |         |         |                                          | 1st line. |         |         |         |
|                                         | 1 target  | 0        | 1       | 0       |                                          | 1 target  | 0       | 1       | 0       |
|                                         | 2 "       | 0        | 0       | 0       |                                          | 2 "       | 1       | 0       | 0       |
|                                         | 3 "       | 0        | 0       | 1       |                                          | 3 "       | 2       | 0       | 0       |
|                                         | 4 "       | 0        | 1       | 0       |                                          | 4 "       | 0       | 1       | 0       |
|                                         | 5 "       | 0        | 0       | 2       |                                          | 5 "       | 0       | 1       | 0       |
|                                         | 2nd line. |          |         |         |                                          | 2nd line. |         |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                          | 1 target  | 0       | 0       | 0       |
|                                         | 2 "       | 0        | 0       | 1       |                                          | 2 "       | 0       | 0       | 0       |
|                                         | 3 "       | 0        | 0       | 0       |                                          | 3 "       | 1       | 0       | 0       |
|                                         | 4 "       | 0        | 0       | 0       |                                          | 4 "       | 0       | 0       | 0       |
|                                         | 5 "       | 0        | 0       | 0       |                                          | 5 "       | 0       | 0       | 0       |
|                                         | 3rd line. |          |         |         |                                          | 3rd line. |         |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                          | 1 target  | 0       | 0       | 0       |
|                                         | 2 "       | 0        | 0       | 0       |                                          | 2 "       | 0       | 0       | 0       |
|                                         | 3 "       | 0        | 0       | 0       |                                          | 3 "       | 0       | 0       | 1       |
|                                         | 4 "       | 0        | 0       | 0       |                                          | 4 "       | 0       | 0       | 0       |
|                                         | 5 "       | 0        | 0       | 0       |                                          | 5 "       | 0       | 0       | 0       |

| —                                       | —         | Through. | Lodged. | Struck. |
|-----------------------------------------|-----------|----------|---------|---------|
| Struck 8 ft. 6 in.<br>above the ground. | 1st line. |          |         |         |
|                                         | 1 target  | 0        | 1       | 0       |
|                                         | 2 "       | 0        | 0       | 0       |
|                                         | 3 "       | 0        | 0       | 1       |
|                                         | 4 "       | 0        | 0       | 0       |
|                                         | 5 "       | 1        | 0       | 1       |
|                                         | 2nd line. |          |         |         |
|                                         | 1 target  | 0        | 0       | 0       |
|                                         | 2 "       | 0        | 0       | 1       |
|                                         | 3 "       | 0        | 0       | 0       |
|                                         | 4 "       | 0        | 0       | 0       |
|                                         | 5 "       | 1        | 0       | 0       |
|                                         | 3rd line. |          |         |         |
|                                         | 1 target  | 0        | 0       | 0       |
|                                         | 2 "       | 0        | 0       | 0       |
|                                         | 3 "       | 0        | 0       | 0       |
|                                         | 4 "       | 0        | 0       | 0       |
|                                         | 5 "       | 0        | 0       | 2       |



SEGMENT SHELL—*continued.*

September 8, 1864.

RANGE, 1,300 yards.

Shell to burst 100 yards in front of target.  
From 9 to 18 feet from the ground.

|                                          |           | Through. | Lodged. | Struck. |                                          |           | Through. | Lodged. | Struck. |
|------------------------------------------|-----------|----------|---------|---------|------------------------------------------|-----------|----------|---------|---------|
| Struck 13 ft. 6 in.<br>above the ground. | 1st line. |          |         |         | Struck 11 ft. 3 in.<br>above the ground. | 1st line. |          |         |         |
|                                          | 1 target  | 0        | 0       | 0       |                                          | 1 target  | 0        | 0       | 0       |
|                                          | 2 "       | 0        | 0       | 2       |                                          | 2 "       | 0        | 0       | 1       |
|                                          | 3 "       | 0        | 0       | 1       |                                          | 3 "       | 1        | 0       | 0       |
|                                          | 4 "       | 1        | 1       | 1       |                                          | 4 "       | 0        | 0       | 1       |
|                                          | 5 "       | 0        | 1       | 0       |                                          | 5 "       | 0        | 0       | 0       |
|                                          | 2nd line. |          |         |         |                                          | 2nd line. |          |         |         |
|                                          | 1 target  | 0        | 0       | 0       |                                          | 1 target  | 0        | 0       | 0       |
|                                          | 2 "       | 0        | 0       | 0       |                                          | 2 "       | 0        | 0       | 0       |
|                                          | 3 "       | 0        | 0       | 0       |                                          | 3 "       | 0        | 0       | 1       |
|                                          | 4 "       | 0        | 1       | 0       |                                          | 4 "       | 1        | 0       | 0       |
|                                          | 5 "       | 0        | 0       | 0       |                                          | 5 "       | 0        | 0       | 0       |
|                                          | 3rd line. |          |         |         |                                          | 3rd line. |          |         |         |
|                                          | 1 target  | 0        | 0       | 0       |                                          | 1 target  | 0        | 0       | 0       |
|                                          | 2 "       | 0        | 0       | 0       |                                          | 2 "       | 0        | 0       | 0       |
| Struck 10 ft. above<br>the ground.       | 3 "       | 0        | 1       | 1       | Struck 10 ft. 6 in.<br>above the ground. | 3 "       | 0        | 0       | 0       |
|                                          | 4 "       | 0        | 0       | 0       |                                          | 4 "       | 0        | 0       | 0       |
|                                          | 5 "       | 0        | 0       | 0       |                                          | 5 "       | 0        | 0       | 0       |
|                                          | 1st line. |          |         |         |                                          | 1st line. |          |         |         |
|                                          | 1 target  | 1        | 1       | 0       |                                          | 1 target  | 0        | 1       | 1       |
|                                          | 2 "       | 0        | 0       | 0       |                                          | 2 "       | 2        | 0       | 2       |
|                                          | 3 "       | 0        | 0       | 2       |                                          | 3 "       | 0        | 0       | 1       |
|                                          | 4 "       | 0        | 1       | 0       |                                          | 4 "       | 1        | 1       | 0       |
|                                          | 5 "       | 2        | 0       | 0       |                                          | 5 "       | 0        | 0       | 0       |
|                                          | 2nd line. |          |         |         |                                          | 2nd line. |          |         |         |
|                                          | 1 target  | 0        | 0       | 1       |                                          | 1 target  | 0        | 0       | 0       |
|                                          | 2 "       | 0        | 0       | 0       |                                          | 2 "       | 1        | 0       | 0       |
|                                          | 3 "       | 0        | 0       | 0       |                                          | 3 "       | 0        | 0       | 0       |
|                                          | 4 "       | 0        | 0       | 0       |                                          | 4 "       | 0        | 0       | 0       |
|                                          | 5 "       | 0        | 0       | 0       |                                          | 5 "       | 0        | 0       | 0       |
|                                          | 3rd line. |          |         |         |                                          | 3rd line. |          |         |         |
|                                          | 1 target  | 0        | 0       | 0       |                                          | 1 target  | 0        | 0       | 0       |
|                                          | 2 "       | 0        | 0       | 0       |                                          | 2 "       | 0        | 0       | 1       |
|                                          | 3 "       | 0        | 0       | 0       |                                          | 3 "       | 0        | 0       | 0       |
|                                          | 4 "       | 0        | 0       | 0       |                                          | 4 "       | 0        | 0       | 0       |
|                                          | 5 "       | 0        | 0       | 0       |                                          | 5 "       | 0        | 0       | 0       |

SEGMENT SHELL—*continued.*

September 13, 1864.

RANGE, 1,300 yards.

Segment shell with percussion fuzes, fired so as to strike the ground at different distances in front of the targets and burst on graze.

The targets consisted of three lines of 2-inch deal targets 9 × 9 feet, 5 in each line, 6 yards interval between the lines.

|                       |           | Through. | Lodged. | Struck. |                        |           | Through. | Lodged. | Struck. |
|-----------------------|-----------|----------|---------|---------|------------------------|-----------|----------|---------|---------|
| Struck 8 yards short. | 1st line. |          |         |         | Struck 31 yards short. | 1st line. |          |         |         |
|                       | 1 target  | 0        | 0       | 0       |                        | 1 target  | 9        | 0       | 0       |
|                       | 2 "       | 0        | 0       | 0       |                        | 2 "       | 2        | 0       | 2       |
|                       | 3 "       | 35       | 5       | 13      |                        | 3 "       | 4        | 1       | 1       |
|                       | 4 "       | 0        | 0       | 0       |                        | 4 "       | 8        | 0       | 0       |
|                       | 5 "       | 0        | 0       | 0       |                        | 5 "       | 1        | 0       | 0       |
|                       | 2nd line. |          |         |         |                        | 2nd line. |          |         |         |
|                       | 1 target  | 0        | 0       | 0       |                        | 1 target  | 0        | 0       | 2       |
|                       | 2 "       | 0        | 0       | 0       |                        | 2 "       | 2        | 0       | 0       |
|                       | 3 "       | 13       | 9       | 17      |                        | 3 "       | 2        | 1       | 4       |
|                       | 4 "       | 2        | 7       | 11      |                        | 4 "       | 0        | 1       | 1       |
|                       | 5 "       | 3        | 9       | 4       |                        | 5 "       | 0        | 0       | 4       |
|                       | 3rd line. |          |         |         |                        | 3rd line. |          |         |         |
|                       | 1 target  | 1        | 0       | 0       |                        | 1 target  | 1        | 0       | 1       |
|                       | 2 "       | 4        | 1       | 1       |                        | 2 "       | 0        | 2       | 1       |
| Struck 6 yards short. | 3 "       | 2        | 1       | 4       | Struck 46 yards short. | 3 "       | 0        | 1       | 3       |
|                       | 4 "       | 0        | 0       | 2       |                        | 4 "       | 0        | 0       | 0       |
|                       | 5 "       | 0        | 0       | 0       |                        | 5 "       | 0        | 0       | 0       |
|                       | 1st line. |          |         |         |                        | 1st line. |          |         |         |
|                       | 1 target  | 0        | 0       | 0       |                        | 1 target  | 1        | 1       | 1       |
|                       | 2 "       | 0        | 0       | 0       |                        | 2 "       | 4        | 4       | 1       |
|                       | 3 "       | 29       | 2       | 11      |                        | 3 "       | 1        | 3       | 1       |
|                       | 4 "       | 0        | 0       | 0       |                        | 4 "       | 3        | 1       | 1       |
|                       | 5 "       | 0        | 0       | 0       |                        | 5 "       | 1        | 2       | 1       |
|                       | 2nd line. |          |         |         |                        | 2nd line. |          |         |         |
|                       | 1 target  | 0        | 0       | 0       |                        | 1 target  | 0        | 1       | 0       |
|                       | 2 "       | 4        | 1       | 1       |                        | 2 "       | 12       | 0       | 1       |
|                       | 3 "       | 27       | 15      | 18      |                        | 3 "       | 0        | 0       | 3       |
|                       | 4 "       | 0        | 4       | 3       |                        | 4 "       | 0        | 1       | 3       |
|                       | 5 "       | 0        | 0       | 0       |                        | 5 "       | 0        | 1       | 0       |
|                       | 3rd line. |          |         |         |                        | 3rd line. |          |         |         |
|                       | 1 target  | 0        | 0       | 0       |                        | 1 target  | 0        | 0       | 0       |
|                       | 2 "       | 0        | 0       | 0       |                        | 2 "       | 0        | 0       | 0       |
|                       | 3 "       | 1        | 1       | 0       |                        | 3 "       | 0        | 1       | 0       |
|                       | 4 "       | 0        | 0       | 0       |                        | 4 "       | 0        | 0       | 0       |
|                       | 5 "       | 0        | 0       | 0       |                        | 5 "       | 0        | 0       | 0       |

|                        |           | Through. | Lodged. | Struck. |
|------------------------|-----------|----------|---------|---------|
| Struck 70 yards short. | 1st line. |          |         |         |
|                        | 1 target  | 1        | 0       | 1       |
|                        | 2 "       | 1        | 2       | 1       |
|                        | 3 "       | 1        | 2       | 1       |
|                        | 4 "       | 0        | 2       | 0       |
|                        | 5 "       | 1        | 0       | 0       |
|                        | 2nd line. |          |         |         |
|                        | 1 target  | 0        | 0       | 0       |
|                        | 2 "       | 0        | 0       | 0       |
|                        | 3 "       | 0        | 0       | 0       |
|                        | 4 "       | 0        | 1       | 1       |
|                        | 5 "       | 1        | 1       | 0       |
|                        | 3rd line. |          |         |         |
|                        | 1 target  | 0        | 0       | 0       |
|                        | 2 "       | 0        | 0       | 0       |
|                        | 3 "       | 0        | 0       | 0       |
|                        | 4 "       | 0        | 0       | 0       |
|                        | 5 "       | 0        | 0       | 0       |



SEGMENT SHELL—*continued.*

September 14, 1864.

RANGE, 800 yards.

Segment shell, with percussion fuzes, fired to strike the ground at different distances in front of the target and burst on graze.

The target consisted of 7 deal targets, 9' × 9' × 2".

| —                      | —        | Through. | Lodged. | Struck. | —                      | —        | Through. | Lodged. | Struck. |
|------------------------|----------|----------|---------|---------|------------------------|----------|----------|---------|---------|
| Struck 60 yards short. | 1 target | 1        | 0       | 0       | Struck 26 yards short. | 1 target | 0        | 1       | 0       |
|                        | 2 "      | 6        | 2       | 2       |                        | 2 "      | 1        | 0       | 0       |
|                        | 3 "      | 3        | 2       | 1       |                        | 3 "      | 5        | 3       | 1       |
|                        | 4 "      | 4        | 3       | 1       |                        | 4 "      | 13       | 1       | 3       |
|                        | 5 "      | 5        | 0       | 2       |                        | 5 "      | 11       | 1       | 5       |
|                        | 6 "      | 6        | 1       | 3       |                        | 6 "      | 1        | 1       | 0       |
|                        | 7 "      | 0        | 0       | 0       |                        | 7 "      | 0        | 0       | 0       |
| Struck 39 yards short. | 1 target | 0        | 0       | 1       | Struck 17 yards short. | 1 target | 0        | 0       | 0       |
|                        | 2 "      | 3        | 0       | 0       |                        | 2 "      | 0        | 0       | 0       |
|                        | 3 "      | 4        | 1       | 4       |                        | 3 "      | 16       | 5       | 8       |
|                        | 4 "      | 11       | 4       | 4       |                        | 4 "      | 36       | 2       | 5       |
|                        | 5 "      | 8        | 1       | 3       |                        | 5 "      | 15       | 5       | 6       |
|                        | 6 "      | 11       | 0       | 2       |                        | 6 "      | 0        | 0       | 0       |
|                        | 7 "      | 0        | 0       | 1       |                        | 7 "      | 0        | 0       | 0       |
| Struck 23 yards short. | 1 target | 0        | 0       | 0       | Struck 36 yards short. | 1 target | 0        | 0       | 0       |
|                        | 2 "      | 1        | 0       | 0       |                        | 2 "      | 1        | 0       | 1       |
|                        | 3 "      | 1        | 0       | 0       |                        | 3 "      | 12       | 2       | 3       |
|                        | 4 "      | 17       | 5       | 3       |                        | 4 "      | 12       | 0       | 5       |
|                        | 5 "      | 14       | 3       | 1       |                        | 5 "      | 2        | 1       | 0       |
|                        | 6 "      | 1        | 0       | 1       |                        | 6 "      | 8        | 1       | 0       |
|                        | 7 "      | 0        | 0       | 1       |                        | 7 "      | 4        | 1       | 1       |
| Struck 69 yards short. | 1 target | 4        | 1       | 0       | Struck 27 yards short. | 1 target | 0        | 0       | 0       |
|                        | 2 "      | 4        | 1       | 0       |                        | 2 "      | 0        | 0       | 0       |
|                        | 3 "      | 1        | 2       | 1       |                        | 3 "      | 3        | 0       | 2       |
|                        | 4 "      | 6        | 1       | 0       |                        | 4 "      | 7        | 4       | 2       |
|                        | 5 "      | 3        | 0       | 0       |                        | 5 "      | 11       | 2       | 4       |
|                        | 6 "      | 0        | 0       | 1       |                        | 6 "      | 2        | 1       | 0       |
|                        | 7 "      | 1        | 0       | 0       |                        | 7 "      | 2        | 0       | 0       |
|                        |          |          |         |         | Bad line.              |          |          |         |         |

F U Z E S.

September 15, 1864.

The time fuze was set at .5 of an inch, and the time of burning taken with stop clocks.

Elevation of gun 3°.

| Stop<br>Clocks. | 1st<br>Round. | 2nd<br>Round. | 3rd<br>Round. | 4th<br>Round. | 5th<br>Round. |
|-----------------|---------------|---------------|---------------|---------------|---------------|
| No. 1 -         | Sec.          | Sec.          | Sec.          | Sec.          | Sec.          |
| No. 2 -         | —             | 1.2           | 1.2           | 1.2           | 1.3           |
| No. 3 -         | 1.2           | 1.1           | 1.3           | 1.1           | 1.2           |
| No. 3 -         | 1.7           | 1.2           | 1.1           | 1.2           | 1.2           |

Elevation of gun 4°.

| Stop<br>Clocks. | 1st<br>Round. | 2nd<br>Round. | 3rd<br>Round. | 4th<br>Round. | 5th<br>Round. |
|-----------------|---------------|---------------|---------------|---------------|---------------|
| No. 1 -         | Sec.          | Sec.          | Sec.          | Sec.          | Sec.          |
| No. 2 -         | 3.9           | 1.3           | 1.1           | 1.3           | —             |
| No. 3 -         | 3.8           | 1.3           | 1.0           | 1.2           | 1.0           |
| No. 3 -         | 3.8           | 1.3           | 1.1           | 1.2           | 1.1           |

Elevation at 4°.

| Stop<br>Clocks. | 1st<br>Round. | 2nd<br>Round. | 3rd<br>Round. | 4th<br>Round. | 5th<br>Round. |
|-----------------|---------------|---------------|---------------|---------------|---------------|
| No. 1 -         | Sec.          | Sec.          | Sec.          | Sec.          | Sec.          |
| No. 2 -         | 1.1           | 1.0           | 1.3           | 1.1           | 1.0           |
| No. 3 -         | 1.2           | 1.0           | 1.5           | 1.1           | 1.0           |
| No. 3 -         | 1.1           | 1.2           | 1.3           | 1.0           | 1.0           |

Percussion fuzes fired to graze on water.

|             | Eleva-<br>tion 0°. |        | Eleva-<br>tion 1°. |        | Eleva-<br>tion 2°. |        | Eleva-<br>tion 3°. |        | Eleva-<br>tion 4°. |        | Eleva-<br>tion 5°. |        | Eleva-<br>tion 6°. |        | Eleva-<br>tion 7°. |        |
|-------------|--------------------|--------|--------------------|--------|--------------------|--------|--------------------|--------|--------------------|--------|--------------------|--------|--------------------|--------|--------------------|--------|
|             | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. |
| 1st round - | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      |
| 2nd round - | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      |

Time fuzes set at 1.25 inches.

Elevation of gun 5°.

| Stop<br>Clocks. | 1st<br>Round. | 2nd<br>Round. | 3rd<br>Round. | 4th<br>Round. | 5th<br>Round. |
|-----------------|---------------|---------------|---------------|---------------|---------------|
| No. 1 -         | Sec.          | Sec.          | Sec.          | Sec.          | Sec.          |
| No. 2 -         | 4.1           | Blind.        | Blind.        | 2.8           | 2.7           |
| No. 3 -         | 4.2           | Blind.        | Blind.        | 2.7           | 2.6           |
| No. 3 -         | 4.4           | Blind.        | Blind.        | 2.8           | 2.6           |

Time fuzes set to 3 inches.

Elevation of gun 6°.

| Stop<br>Clocks. | 1st<br>Round. | 2nd<br>Round. | 3rd<br>Round. | 4th<br>Round. | 5th<br>Round. |
|-----------------|---------------|---------------|---------------|---------------|---------------|
| No. 1 -         | Sec.          | Sec.          | Sec.          | Sec.          | Sec.          |
| No. 2 -         | 6.2           | 6.2           | Blind.        | 6.5           | 6.4           |
| No. 3 -         | 6.2           | 6.2           | Blind.        | 6.4           | 6.4           |
| No. 3 -         | 6.2           | 6.2           | Blind.        | 6.5           | 6.5           |

Time fuzes set to 1.75 inches.

Elevation of gun 6°.

| Stop<br>Clocks. | 1st<br>Round. | 2nd<br>Round. | 3rd<br>Round. | 4th<br>Round. | 5th<br>Round. |
|-----------------|---------------|---------------|---------------|---------------|---------------|
| No. 1 -         | Sec.          | Sec.          | Sec.          | Sec.          | Sec.          |
| No. 2 -         | 4.5           | 3.7           | 4.0           | Blind.        | Blind.        |
| No. 3 -         | 4.7           | 3.7           | 4.0           | Blind.        | Blind.        |
| No. 3 -         | 4.6           | 3.7           | 4.0           | Blind.        | Blind.        |

Percussion fuzes made to graze on sand.

|           | Eleva-<br>tion 0°. |        | Eleva-<br>tion 1°. |        | Eleva-<br>tion 2°. |        | Eleva-<br>tion 3°. |        | Eleva-<br>tion 4°. |        |
|-----------|--------------------|--------|--------------------|--------|--------------------|--------|--------------------|--------|--------------------|--------|
|           | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. |
| 1st round | 1                  | -      | -                  | 1      | 1                  | -      | 1                  | -      | 1                  | -      |
| 2nd round | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      |



## ROUGH USAGE.

*Practice on the 18th October 1864.*

The 12-pounders that had been in the muddy ditch all night were this morning taken out, and, with the view of ascertaining which of the guns could be got ready for action in the shortest possible time, the following experiment was carried out:—

The three guns being in the condition that they were in when taken out of the ditch, viz., covered more or less with thick mud, and with their bores more or less full of the same, were placed on the sea wall, detachments told off for them, and 10 rounds solid shot were fired from each as rapidly as possible, the time being taken from the word "load."

## RESULTS:—

Fired the 1st round in 2 min. 25 secs.  
 " 10th " 7 min. 15 secs.

*Note.*—Very considerable delay (amounting probably to 1 min. 30 secs.) was here experienced in firing the 1st round, owing to the ignorance and stupidity of the man whose duty it was to enter cartridge and projectile; a delay of about 30 secs., owing to the same cause, was also experienced in firing the 2nd round.

## EFFECT OF PREMATURE BURSTING OF SHELL IN THE BORE.

4. Common shell,
5. Segment shell,

were burst as nearly as possible at the seat of the shot.

To insure this a hole was bored through the base of the shell, the lubricator and end of the cartridge removed so as to bring the charge in contact with the burster of the shell.

The gun was slightly dented.

10 rounds solid shot were fired at a target; the result showed that the accuracy of the gun was not impaired.

*October 28.*

The 10 rounds solid shot,  
 10 " segment shell,  
 10 " common shell,

which were placed in wet straw in April last and periodically wetted with sea water were fired to-day.

The ammunition did not appear to be in any way damaged.

*December 22, 1864.*

The gun was laid on skidding on the sand, and fired at with a 9-pounder Armstrong gun with solid shot. Charge,  $1\frac{1}{4}$  lb. Range, 40 yards.

*1st Shot.*—Struck the gun on the edge of the coil in front of the trunnion hoop, indented the coil, and made a slight crack in it  $\frac{1}{4}$ -in. in length. The shot ricocheted on to the shoulder of the trunnion, and made a small dent.

The direction of the shot was at an angle of  $30^\circ$  with the axis of the gun.

Inside of the gun not damaged.

*2nd Shot.*—The gun was placed so as it should be hit direct by the shot. It was struck on the edge of the same coil again, and the gun was knocked 2 feet off the skidding; the coil had a piece about 3 inches in diameter scooped out of it, and a small dent was visible in the bore, the coil was loosened at the edge.

The gun was subsequently fired 4 rounds without difficulty.

## RAPID FIRING.

*April 19, 1864.*

200 rounds of solid shot were fired, not as a competition as to rapidity of firing, but the firing was continuous, carried on as rapidly as service considerations would admit of.

The gun detachments consisted of six men each, and were relieved every 30 rounds.

The position of the gun was determined by lot.

The gun detachments and officers were selected also by lot.

The time taken in firing the 200 rounds was as follows :—

1 hour 20 minutes.

At the 43rd round water was used to the breech screw at the request of Sir W. Armstrong, and frequently afterwards.

At the 84th round the breech screw stuck, and required considerable force to move it, the delay was trifling.

Oil was also used to this gun continually after the 43rd round.

At the conclusion of this firing the gun fired 8 rounds of common shell (blind) at 9-foot targets, 300 yards range, to hit the bull's eye ; 3 first rounds trial shots ; 5 last recorded.

|    |       |                     |
|----|-------|---------------------|
| 1. | 26    | inches from centre. |
| 2. | 21    | " "                 |
| 3. | 14.75 | " "                 |
| 4. | 13.75 | " "                 |
| 5. | 4.5   | " "                 |

The 3 vent pieces were used.

*May 19, 1864.*

99 rounds solid shot were fired entirely by men of the Royal Artillery, the gun detachment being changed every 20 rounds until 60 rounds had been fired, and afterwards every 13 until the conclusion of the experiment.

One 6-foot floating target. Range, 1,200 yards. Elevation, 2° 40'.

The times were as follows :—

|                  | Min. | Sec. |
|------------------|------|------|
| 1st 20 rounds in | 8    | 8    |
| 2nd 20           | 12   | 21   |
| 3rd 20           | 10   | 52   |
| 1st 13           | 5    | 6    |
| 2nd 13           | 8    | 15   |
| 3rd 13           | 6    | 39   |
| Total            | 51   | 21   |

The vent pieces were changed every time with the detachments, and a wet cloth was used to the breech-screw and slot occasionally after 40 rounds.

The upper keep pin of the tappet was removed by Sir W. Armstrong before commencing the experiments. 31 hits on target.

*June 1, 1864.*

100 rounds solid shot were fired by men of the Royal Artillery at targets at various distances. The detachments were changed every 20 rounds. *First 2 rounds trial.*

The times were as follows :—

|           | Min. | Sec. |
|-----------|------|------|
| 18 rounds | 5    | 57   |
| 20        | 7    | 5    |
| 20        | 7    | 30   |
| 20        | 7    | 57   |
| 20        | 6    | 20   |
| Total     | 35   | 34   |

Neither oil nor water were used during the firing. The vent piece was changed 3 times. Two miss fires.

## WITHOUT LUBRICATORS.

*November 10.*

20 rounds solid shot were fired without lubrication.

Time—11 minutes.

Two shot stripped.

66 rounds were to be fired as rapidly as possible, but this gun did not complete them, as from the practice it was evident this gun could not be used without lubrication, owing to the lead stripping from the shot.

The detachments were changed so that each detachment worked each gun, and at the conclusion of the practice Nos. 1, 2, 3 were asked their opinion as to ease of working.—

No. 1 preferred Whitworth as easier to lay.  
2 " M.L. Armstrong " " load.  
3 " Whitworth could give no reason.

All agreed that the muzzle loading guns were far preferable to the breech loader.





SIR W. ARMSTRONG'S PROGRAMME—*continued.*

| No. of Round.      | Range.       | 1st Graze. |        |        | Remarks.                                                                                                                                                                                |          |              |  |       |    |         |       |    |        |
|--------------------|--------------|------------|--------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|--|-------|----|---------|-------|----|--------|
|                    |              | In Line.   | Right. | Left.  |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| October 27, 1864.  |              |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
|                    | Yards.       |            | Yards. | Yards. |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1                  | 1,059        | —          | 1·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 2                  | 1,154        | —          | 2·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3                  | 1,167        | —          | 1·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 4                  | 1,182        | Yes.       | —      | —      | Lead attached by zinc.                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 5                  | 1,213        | —          | —      | 0·4    |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 6                  | 1,147        | Yes.       | —      | —      | Weather :—Foggy.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 7                  | 1,179        | —          | —      | 0·4    |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 8                  | 1,154        | —          | 2·0    | —      | Wind :—Direction, N. ; force, 1 ; 10 a.m.                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 9                  | 1,145        | —          | —      | 0·6    | „ W. by N. ; „ 2 ; 3 p.m.                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 10                 | 1,158        | —          | —      | 0·2    |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 11                 | 1,175        | —          | —      | 0·4    | Thermometer :—55 dry, 54 wet, 10 a.m.                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 12                 | 1,145        | —          | —      | 0·6    | 56 „ 56 „ 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 13                 | 1,174        | —          | —      | 2·4    |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 14                 | 1,146        | —          | —      | 0·6    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>29·28</td><td>56</td><td>10 a.m.</td></tr><tr><td>29·35</td><td>56</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 29·28 | 56 | 10 a.m. | 29·35 | 56 | 3 p.m. |
| Reading.           | Temperature. |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29·28              | 56           | 10 a.m.    |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29·35              | 56           | 3 p.m.     |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 15                 | 1,190        | —          | —      | 1·0    |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 16                 | 1,177        | Yes.       | —      | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 17                 | 1,175        | Yes.       | —      | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 18                 | 1,186        | —          | —      | 1·6    |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19                 | 1,190        | —          | —      | 0·2    |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20                 | 1,169        | —          | 0·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| November 25, 1864. |              |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1                  | 1,923        | —          | —      | 18·2   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 2                  | 1,910        | —          | —      | 18·0   | Zincd S. shell.                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3                  | 1,911        | —          | —      | 20·8   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 4                  | 1,907        | —          | —      | 17·0   | Weather :—Clear.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 5                  | 1,920        | —          | —      | 20·0   | Wind :—Direction, W. ; force, 3 ; 10 a.m.                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 6                  | 1,906        | —          | —      | 19·4   | „ S.W. ; „ 3 ; 3 p.m.                                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 7                  | 1,915        | —          | —      | 20·4   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 8                  | 1,912        | —          | —      | 19·0   | Thermometer :—39 dry, 38 wet, 10 a.m.                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 9                  | 1,949        | —          | —      | 18·0   | 43 „ 40 „ 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 10                 | 1,910        | —          | —      | 18·4   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 11                 | 1,936        | —          | —      | 19·0   | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>29·40</td><td>44</td><td>10 a.m.</td></tr><tr><td>29·45</td><td>46</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 29·40 | 44 | 10 a.m. | 29·45 | 46 | 3 p.m. |
| Reading.           | Temperature. |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29·40              | 44           | 10 a.m.    |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29·45              | 46           | 3 p.m.     |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 12                 | 1,904        | —          | —      | 18·8   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 13                 | 1,897        | —          | —      | 18·0   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 14                 | 1,939        | —          | —      | 19·6   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 15                 | 1,924        | —          | —      | 18·8   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 16                 | 1,968        | —          | —      | 20·0   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 17                 | 2,003        | —          | —      | 20·4   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 18                 | 1,936        | —          | —      | 19·6   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19                 | 1,909        | —          | —      | 18·8   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20                 | 1,862        | —          | —      | 17·0   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| October 26, 1864.  |              |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1                  | 2,242        | —          | 18·0   | —      | Shot, lead attached by zinc.                                                                                                                                                            |          |              |  |       |    |         |       |    |        |
| 2                  | 2,200        | —          | 16·0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3                  | 2,212        | —          | 16·2   | —      | Weather :—Cloudy, 10 a.m.                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 4                  | 2,250        | —          | 15·0   | —      | Hazy, 3 p.m.                                                                                                                                                                            |          |              |  |       |    |         |       |    |        |
| 5                  | 2,243        | —          | 17·2   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 6                  | 2,214        | —          | 17·4   | —      | Wind :—Direction, E. ; force, 3 ; 10 a.m.                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 7                  | 2,208        | —          | 17·0   | —      | „ E. by N. ; „ 3 ; 3 p.m.                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 8                  | 2,232        | —          | 18·2   | —      | Thermometer :—54 dry, 54 wet, 10 a.m.                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 9                  | 2,212        | —          | 15·2   | —      | 57 „ 56 „ 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 10                 | 2,193        | —          | 15·0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 11                 | 2,214        | —          | 14·4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 12                 | 2,193        | —          | 21·0   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>29·38</td><td>55</td><td>10 a.m.</td></tr><tr><td>29·30</td><td>55</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 29·38 | 55 | 10 a.m. | 29·30 | 55 | 3 p.m. |
| Reading.           | Temperature. |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29·38              | 55           | 10 a.m.    |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29·30              | 55           | 3 p.m.     |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 13                 | 2,240        | —          | 17·4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 14                 | 2,245        | —          | 14·2   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 15                 | 2,200        | —          | 15·0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 16                 | 2,150        | —          | 14·0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 17                 | 2,200        | —          | 20·4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 18                 | 2,234        | —          | 18·0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19                 | 2,176        | —          | 17·4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20                 | 2,158        | —          | 15·0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |



## SIR W. ARMSTRONG'S PROGRAMME—continued.

| No. of Round. | Range.       | 1st Graze. |        |        | Remarks.                                                                                                                                                                                |          |              |  |       |    |         |       |    |        |
|---------------|--------------|------------|--------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|--|-------|----|---------|-------|----|--------|
|               |              | In Line.   | Right. | Left.  |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
|               | Yards.       |            | Yards. | Yards. | <i>November 25, 1864.</i>                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 1             | 1,143        | —          | 2·0    | —      | Shot, lead attached by zinc.                                                                                                                                                            |          |              |  |       |    |         |       |    |        |
| 2             | 1,214        | —          | 2·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3             | 1,230        | —          | —      | 0·4    | Weather :—Clear.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 4             | 1,169        | —          | 0·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 5             | 1,192        | —          | 2·8    | —      | Wind :—Direction, W. ; force, 3 ; 10 a.m.                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 6             | 1,178        | —          | 2·4    | —      | „ S.W. „ 3 ; 3 p.m.                                                                                                                                                                     |          |              |  |       |    |         |       |    |        |
| 7             | 1,164        | —          | 1·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 8             | 1,146        | —          | 1·0    | —      | Thermometer :—39 dry, 38 wet, 10 a.m.                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 9             | 1,190        | —          | 0·2    | —      | 43 „ 40 „ 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 10            | 1,190        | —          | 1·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 11            | 1,199        | —          | 0·2    | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>29·40</td><td>44</td><td>10 a.m.</td></tr><tr><td>29·45</td><td>46</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 29·40 | 44 | 10 a.m. | 29·45 | 46 | 3 p.m. |
| Reading.      | Temperature. |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29·40         | 44           | 10 a.m.    |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29·45         | 46           | 3 p.m.     |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 12            | 1,184        | —          | 1·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 13            | 1,162        | —          | 1·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 14            | 1,204        | —          | 1·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 15            | 1,194        | Yes.       | —      | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 16            | 1,186        | —          | 1·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 17            | 1,201        | —          | 2·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 18            | 1,192        | —          | —      | 0·2    |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19            | 1,190        | —          | 2·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20            | 1,182        | Yes.       | —      | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 21            | 1,200        | —          | —      | 0·3    |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 22            | 1,159        | —          | 1·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 23            | 1,200        | —          | 0·8    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 24            | 1,198        | —          | 1·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 25            | 1,186        | Yes.       | —      | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 26            | 1,179        | —          | 2·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 27            | 1,169        | —          | —      | 1·0    |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 28            | 1,194        | —          | 1·8    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29            | 1,197        | —          | 1·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 30            | 1,200        | —          | 0·8    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 31            | 1,196        | —          | 0·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 32            | 1,153        | —          | 2·8    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 33            | 1,164        | —          | 0·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 34            | 1,155        | —          | 1·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 35            | 1,171        | —          | 1·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 36            | 1,189        | —          | —      | 0·6    |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 37            | 1,173        | —          | 0·8    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 38            | 1,209        | —          | 2·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 39            | 1,208        | —          | 1·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 40            | 1,220        | —          | 1·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
|               |              |            |        |        | <i>November 24, 1864.</i>                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 1             | 1,776        | —          | —      | 12·0   | Undercut, S. shell.                                                                                                                                                                     |          |              |  |       |    |         |       |    |        |
| 2             | 2,003        | —          | —      | 14·4   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3             | 1,946        | —          | —      | 15·0   | Weather :—Cloudy, 10 a.m.                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 4             | 1,948        | —          | —      | 18·6   | Very hazy, 3 p.m.                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 5             | 2,039        | —          | —      | 17·4   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 6             | 1,938        | —          | —      | 14·0   | Wind :—Direction, N.W. by W. ; force, 7 ; 10 a.m.                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 7             | 2,009        | —          | —      | 15·6   | „ W. „ 3 ; 3 p.m.                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 8             | 1,916        | —          | —      | 13·8   | Thermometer :—41 dry, 40 wet, 10 a.m.                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 9             | 1,938        | —          | —      | 14·0   | 42 „ 41 „ 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 10            | 1,940        | —          | —      | 14·0   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 11            | 1,914        | —          | —      | 18·6   | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>29·20</td><td>44</td><td>10 a.m.</td></tr><tr><td>29·25</td><td>44</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 29·20 | 44 | 10 a.m. | 29·25 | 44 | 3 p.m. |
| Reading.      | Temperature. |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29·20         | 44           | 10 a.m.    |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29·25         | 44           | 3 p.m.     |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 12            | 1,972        | —          | —      | 16·0   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 13            | 1,942        | —          | —      | 18·0   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 14            | 1,922        | —          | —      | 17·0   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 15            | 1,930        | —          | —      | 17·6   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 16            | 1,942        | —          | —      | 19·0   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 17            | 2,003        | —          | —      | 20·6   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 18            | 1,898        | —          | —      | 21·0   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19            | 1,925        | —          | —      | 15·6   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20            | 1,913        | —          | —      | 19·4   |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |

SIR W. ARMSTRONG'S PROGRAMME—*continued.*

## FUZES.

October 28, 1864.

Fifty time fuzes with new covers were fired. Time taken by two clocks. Fuze set to 1' inch.

|                 |                 |
|-----------------|-----------------|
| 1. 1.9 seconds. | 6. 1.8 seconds. |
| 2. 1.6 "        | 7. 1.8 "        |
| 3. 1.7 "        | 8. 1.7 "        |
| 4. 1.8 "        | 9. 1.7 "        |
| 5. 1.8 "        | 10. 1.7 "       |

Fuze set to 1.5 inches.

|                 |                 |
|-----------------|-----------------|
| 1. 2.7 seconds. | 6. 2.8 seconds. |
| 2. 2.8 "        | 7. 2.6 "        |
| 3. 2.6 "        | 8. 2.8 "        |
| 4. 2.8 "        | 9. 2.6 "        |
| 5. 2.7 "        | 10. 2.6 "       |

Fuze set to 2.5 inches.

|                 |                 |
|-----------------|-----------------|
| 1. 4.7 seconds. | 6. 4.6 seconds. |
| 2. 4.6 "        | 7. 4.8 "        |
| 3. 4.4 "        | 8. 4.5 "        |
| 4. 4.5 "        | 9. 4.8 "        |
| 5. 4.6 "        | 10. 4.4 "       |

Fuze set to 3 inches.

|                       |                 |
|-----------------------|-----------------|
| 1. 5.3 seconds.       | 6. 5.4 seconds. |
| 2. 5.1 "              | 7. 5.3 "        |
| 3. 5.4 "              | 8. 5.4 "        |
| 4. 5.4 "              | 9. 5.3 "        |
| 5. Time not observed. | 10. 5.2 "       |

Fuze set to 3.5 inches.

|                       |                   |
|-----------------------|-------------------|
| 1. Time not observed. | 6. 6.3 seconds.   |
| 2. 6.3 seconds.       | 7. 6.6 read late. |
| 3. 6.3 "              | 8. 6.3 seconds.   |
| 4. 6.4 "              | 9. 6.5 "          |
| 5. 6.3 "              | 10. 6.2 "         |

## RAPID FIRING.

Nov. 29, 1864.

The following experiment was carried on to show how quickly 100 rounds could be fired from the breech-loading 12-pounder Armstrong gun, by a detail of duties different from that prescribed by the service regulations.

Neither water nor oil was used.

The first 50 rounds were fired as follows :—

|                           |
|---------------------------|
| 10 rounds in 120 seconds. |
| 10 " 85 "                 |
| 10 " 76 "                 |
| 10 " 73 "                 |
| 10 " 75 "                 |

Total, 6 minutes 59 seconds.

The whole of the above were fired with one vent-piece.

At the conclusion of the above 50 rounds 10 minutes' interval was allowed, during which the gun was cleaned, and another 50 rounds fired as follows :—

|                          |
|--------------------------|
| 10 rounds in 84 seconds. |
| 10 " 79 "                |
| 10 " 77 "                |
| 10 " 78 "                |
| 10 " 81 "                |

Total, 6 minutes 39 seconds.

The detachment was selected from the men of the experimental department at Shoeburyness.

The time was taken from the word "load."

A fresh vent-piece was used for the second 50 rounds.



## SEA SERVICE TRIALS.

The gun was mounted on common boat's carriage in the bows of a 32 ft. pinnace.

INDEPENDENT FIRING.—November 3, 1864.—*Portsmouth.*

Ten rounds were fired independently with shot, the boats having very slight but rapid rolling, pitching, and yawing motions.

Wind ; force, 2.

## 12-pounder Armstrong's Breech-loader.

Shot, 12 lbs.  
Charge,  $1\frac{1}{2}$  lbs.  
Distance of target, 1,800 yards.  
Elevation,  $4^{\circ} 20'$ .  
Deflection,  $0^{\circ} 8' L$ .

10 rounds were completed in 9' 55".  
Recoil, 2 ft. 6 in. and a taut breeching.  
The advantage of breech-loading in a boat was very apparent, the operation being performed with ease, and without much exposure of the gun numbers.  
Total numbers gained in this practice - - 39

November 8, 1864.

## DISEMBARKING.

The 12-pounder competitive guns were thrown ashore (on Southsea beach) from the boats, and practised without loss of time as naval field pieces, to ascertain their comparative merits under the circumstances.

Guns, field carriages, and limbers were thrown overboard, as the boats touched the beach, and roused ashore by the drag ropes. The limber boxes were carried on shore by the limber numbers. When the guns were mounted they were "Rear" limbered up and marched about 10 yards higher up the beach; then "Action—Rear," "Load," "1° elevation and lay for the horizon," "Fire," "Cease—Firing."

The following several periods of time are recorded against each gun during the evolutions; the difference between the times connected with the mounting of carriage and limber must be attributed to the crews only; but those connected with the handling of the guns may fairly be due to their difference in weight and handiness.

|                                                             | Armstrong Breech-loader. |    |
|-------------------------------------------------------------|--------------------------|----|
| Boats touching beach to the time when guns were overboard - | m.                       | s. |
| Carriage landed - - -                                       | 0                        | 19 |
| " mounted - - -                                             | 1                        | 14 |
| Limber landed - - -                                         | 1                        | 46 |
| " mounted - - -                                             | 2                        | 21 |
| Gun mounted - - -                                           | 3                        | 10 |
| "Rear—Limber up" - - -                                      | *3                       | 30 |
| "Action—Rear" - - -                                         | 3                        | 40 |
| "Load"† - - -                                               | 4                        | 15 |
| "Fire" - - -                                                | 4                        | 30 |
|                                                             | 6                        | 21 |

Very little cleansing was required; the guns were dragged breech foremost through water, sand, and shingle.

This gun was not sponged out before loading.

## ABSTRACT OF ABOVE PRACTICE.

| 12-pounder guns in Boats. November 3, 1864. Independent firing, 1,800 yards. | Rounds.   | Time. |         | Average Time each Round. | Number awarded for Accuracy.                 | Remarks.                                                              |
|------------------------------------------------------------------------------|-----------|-------|---------|--------------------------|----------------------------------------------|-----------------------------------------------------------------------|
|                                                                              | 10        | m.    | s.      | 59*5                     | 39                                           | Recoil manageable. Charge $\frac{1}{4}$ lb. less than the other guns. |
| 12-pounder gun landed on Southsea beach as field piece.                      | Mounting. |       | Orders. |                          | Remarks.                                     |                                                                       |
|                                                                              | Carriage. | Gun.  | Load.   | Fire.                    |                                              |                                                                       |
|                                                                              | m. s.     | m. s. | m. s.   | m. s.                    | This gun was not sponged out before loading. |                                                                       |
|                                                                              | 1 46      | 3 30  | 4 30    | 6 21                     |                                              |                                                                       |

\* The hole in rear of the breech assisted the men much in allowing the use of a handspike in mounting.

† The order "Load" followed immediately "Action—Rear."





# 12-POUNDER WHITWORTH GUN.

## EXPERIMENTS FOR DETERMINING RANGE AND ACCURACY.

N.B.—The figures in *Italics* are the rounds struck out by the competitors as abnormal shots.

### SOLID SHOT.

SHOEBURYNNESS.

#### Particulars, &c. of Gun No. 264.

Weight, 10 cwt.  
Length, 6 ft. 7.7 in.  
Diameter of circle { circumscribed, 3.012 in.  
                          inscribed, 2.755 "  
Length of bore, 6 ft. 2 in.  
Spiral, 1 turn in 56 inches.

#### Particulars, &c. of Shot and Ammunition.

Weight, 11 lbs. 15.2 oz.  
Length, 8.78 inches.  
Length of cartridge, 10.5 in.  
Diameter of cartridge, 2.57 in.  
Brand of powder, A4.  
Charge, 1½ lbs.  
Wad, Boxer's lubricator, filled with oil ; brush sponge.

| No. of Round. | Elevation. | Range. | Recoil. | 1st Graze. |        | 2nd Graze. |        | 3rd Graze. |        | Remarks.                                                                                                                                                                                                                                                                                                         |
|---------------|------------|--------|---------|------------|--------|------------|--------|------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |            |        |         | Right.     | Range. | Right.     | Range. | Right.     | Range. |                                                                                                                                                                                                                                                                                                                  |
|               | °          | Yards. | Ft. In. | Yards.     | Yards. | Yards.     | Yards. | Yards.     | Yards. | <i>April 4, 1864.</i>                                                                                                                                                                                                                                                                                            |
| 1             | 0          | 607    | 4 9     | 0.4        | 2,389  | 31         | 3,710  | 136        |        | The gun was placed on the line.<br>Weather:—Hazy at 10 a.m.<br>Slight haze at 3 p.m.<br>Wind:—Direction, S.E. by E.; force, 1; 10 a.m.<br>"      N.N.W.;      "      1; 3 p.m.<br>Thermometer:—48 dry, 47 wet, 10 a.m.<br>60 " 58 " 3 p.m.<br>Barometer:—29.75      50      10 a.m.<br>29.95      62      3 p.m. |
| 2             | 0          | 518    | 4 7     | 0.2        | 2,302  | 7          | 3,904  | 160        |        |                                                                                                                                                                                                                                                                                                                  |
| 3             | 0          | 493    | 5 0     | 0.6        | 2,496  | 9.6        | 4,112  | 149        |        |                                                                                                                                                                                                                                                                                                                  |
| 4             | 0          | 515    | 4 10    | 0.8        | 2,082  | 55         | 4,311  | 206        |        |                                                                                                                                                                                                                                                                                                                  |
| 5             | 0          | 528    | 5 0     | 0.6        | 2,070  | 56         | 4,010  | 184        |        |                                                                                                                                                                                                                                                                                                                  |
| 6             | 0          | 501    | 4 11    | 0.6        | 2,020  | 36.6       | 3,943  | 116        |        |                                                                                                                                                                                                                                                                                                                  |
| 7             | 0          | 495    | —       | 0.2        | 1,972  | 45         | 3,960  | 84         |        |                                                                                                                                                                                                                                                                                                                  |
| 8             | 1          | 893    | 5 0     | 2.0        | 2,263  | 67         | 3,600  | 194        |        |                                                                                                                                                                                                                                                                                                                  |
| 9             | 1          | 895    | 4 9     | 0.6        | 2,629  | 37.2       | 4,050  | 48         |        |                                                                                                                                                                                                                                                                                                                  |
| 10            | 1          | 917    | 5 0     | 0.8        | 2,709  | 73         | 4,200  | 160        |        |                                                                                                                                                                                                                                                                                                                  |
| 11            | 1          | 925    | 4 10    | 2.8        | 2,700  | 63         | 4,600  | 176        |        |                                                                                                                                                                                                                                                                                                                  |
| 12            | 1          | 926    | 4 11    | 2.6        | 2,817  | 84         | 4,250  | 102        |        |                                                                                                                                                                                                                                                                                                                  |
| 13            | 1          | 906    | —       | 2.2        | 2,784  | 71         | 3,800  | 90         |        |                                                                                                                                                                                                                                                                                                                  |

| No of Round. | Elevation. | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                                                                                                                                                                                                                     |
|--------------|------------|--------|------------|--------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              |            |        | In Line.   | Right. | Left.  |                                                                                                                                                                                                                                                                                                                                                              |
|              | °          | Yards. |            | Yards. | Yards. |                                                                                                                                                                                                                                                                                                                                                              |
| 1            | 0          | 500    | —          | —      | 4.4    | <i>May 13, 1864.</i><br><br>The gun was 15 feet left of line.<br>Weather:—Very slight haze, 10 a.m.<br>Haze on water, 3 p.m.<br>Wind:—Direction, N.E. by N.; force, 2; 10 a.m.<br>"      S.E. by S.;      "      2; 3 p.m.<br>Thermometer:—61 dry, 58 wet, 10 a.m.<br>62 " 58 " 3 p.m.<br>Barometer:—30.05      58      10 a.m.<br>30.10      61      3 p.m. |
| 2            | "          | 503    | —          | —      | 4.2    |                                                                                                                                                                                                                                                                                                                                                              |
| 3            | "          | 506    | —          | —      | 4.2    |                                                                                                                                                                                                                                                                                                                                                              |
| 4            | "          | 513    | —          | —      | 4.4    |                                                                                                                                                                                                                                                                                                                                                              |
| 5            | "          | 522    | —          | —      | 4.6    |                                                                                                                                                                                                                                                                                                                                                              |
| 6            | "          | 484    | —          | —      | 4.6    |                                                                                                                                                                                                                                                                                                                                                              |
| 7            | "          | 498    | —          | —      | 4.2    |                                                                                                                                                                                                                                                                                                                                                              |
| 8            | "          | 486    | —          | —      | 4.0    |                                                                                                                                                                                                                                                                                                                                                              |
| 9            | "          | 513    | —          | —      | 4.4    |                                                                                                                                                                                                                                                                                                                                                              |
| 10           | "          | 507    | —          | —      | 4.2    |                                                                                                                                                                                                                                                                                                                                                              |
| 11           | "          | 508    | —          | —      | 4.6    |                                                                                                                                                                                                                                                                                                                                                              |
| 12           | "          | 503    | —          | —      | 4.4    |                                                                                                                                                                                                                                                                                                                                                              |
| 13           | "          | 478    | —          | —      | 3.4    |                                                                                                                                                                                                                                                                                                                                                              |
| 14           | "          | 494    | —          | —      | 4.6    |                                                                                                                                                                                                                                                                                                                                                              |
| 15           | "          | 503    | —          | —      | 4.6    |                                                                                                                                                                                                                                                                                                                                                              |
| 16           | "          | 511    | —          | —      | 4.2    |                                                                                                                                                                                                                                                                                                                                                              |
| 17           | "          | 510    | —          | —      | 4.4    |                                                                                                                                                                                                                                                                                                                                                              |
| 18           | "          | 509    | —          | —      | 4.0    |                                                                                                                                                                                                                                                                                                                                                              |
| 19           | "          | 514    | —          | —      | 4.4    |                                                                                                                                                                                                                                                                                                                                                              |
| 20           | "          | 517    | —          | —      | 4.4    |                                                                                                                                                                                                                                                                                                                                                              |
| 1            | 1          | 960    | —          | 0.6    | —      | <i>April 5, 1864.</i><br><br>The gun was in the line<br>Weather:—Clear.<br>Wind:—Direction, N.E. by N.; force, 4; 10 a.m.<br>"      S.E. by E.;      "      3; 3 p.m.<br>Thermometer:—44 dry, 41 wet, 10 a.m.<br>45 " 42 " 3 p.m.<br>Barometer:—30.25      52      10 a.m.<br>30.30      60      3 p.m.                                                      |
| 2            | "          | 932    | —          | 0.4    | —      |                                                                                                                                                                                                                                                                                                                                                              |
| 3            | "          | 943    | —          | —      | 0.4    |                                                                                                                                                                                                                                                                                                                                                              |
| 4            | "          | 914    | —          | 0.2    | —      |                                                                                                                                                                                                                                                                                                                                                              |
| 5            | "          | 924    | —          | —      | 0.2    |                                                                                                                                                                                                                                                                                                                                                              |
| 6            | "          | 940    | Yes.       | —      | —      |                                                                                                                                                                                                                                                                                                                                                              |
| 7            | "          | 910    | —          | 0.2    | —      |                                                                                                                                                                                                                                                                                                                                                              |
| 8            | "          | 949    | —          | 0.4    | —      |                                                                                                                                                                                                                                                                                                                                                              |
| 9            | "          | 928    | —          | 0.8    | —      |                                                                                                                                                                                                                                                                                                                                                              |
| 10           | "          | 937    | —          | 0.8    | —      |                                                                                                                                                                                                                                                                                                                                                              |
| 11           | "          | 939    | —          | —      | 0.4    |                                                                                                                                                                                                                                                                                                                                                              |
| 12           | "          | 918    | —          | 0.6    | —      |                                                                                                                                                                                                                                                                                                                                                              |
| 13           | "          | 909    | —          | 0.2    | —      |                                                                                                                                                                                                                                                                                                                                                              |
| 14           | "          | 924    | —          | 1.2    | —      |                                                                                                                                                                                                                                                                                                                                                              |
| 15           | 2          | 1,331  | —          | 2.2    | —      |                                                                                                                                                                                                                                                                                                                                                              |

## RANGE AND ACCURACY.—SOLID SHOT—continued.

| No. of Round. | Elevation. | Range. | 1st Graze. |        |        | Remarks.                                         |
|---------------|------------|--------|------------|--------|--------|--------------------------------------------------|
|               |            |        | In Line.   | Right. | Left.  |                                                  |
|               | 0          | Yards. |            | Yards. | Yards. |                                                  |
| 1             | 2          | 1,261  | —          | 0·6    | —      | April 11, 1864.                                  |
| 2             | "          | 1,280  | Yes.       | —      | —      |                                                  |
| 3             | "          | 1,284  | Yes.       | —      | —      |                                                  |
| 4             | "          | 1,297  | —          | 0·4    | —      |                                                  |
| 5             | "          | 1,276  | Yes.       | —      | —      | The gun was in line.                             |
| 6             | "          | 1,318  | Yes.       | —      | —      | Weather :—Very thick haze.                       |
| 7             | "          | 1,380  | —          | 0·6    | —      |                                                  |
| 8             | "          | 1,261  | —          | 1·4    | —      | Wind :—Direction, W.N.W. ; force, nil ; 10 a.m.  |
| 9             | "          | 1,268  | Yes.       | —      | —      | " W.S.W. ; " 1 ; 3 p.m.                          |
| 10            | "          | 1,276  | —          | —      | 0·8    |                                                  |
| 11            | "          | 1,276  | —          | —      | 0·6    | Thermometer :—47 dry, 45 wet, 10 a.m.            |
| 12            | "          | 1,300  | —          | —      | 0·2    | 50 " 51 " 3 p.m.                                 |
| 13            | "          | 1,261  | —          | 0·8    | —      | Reading. Temperature.                            |
| 14            | "          | 1,308  | —          | 0·2    | —      | Barometer :—30·10 52 10 a.m.                     |
| 15            | "          | 1,269  | —          | —      | 0·4    | 30·05 54 3 p.m.                                  |
| 16            | "          | 1,292  | —          | 0·2    | —      |                                                  |
| 17            | "          | 1,285  | —          | 0·4    | —      |                                                  |
| 18            | "          | 1,285  | —          | 1·2    | —      |                                                  |
| 19            | "          | 1,296  | —          | 0·4    | —      |                                                  |
| 20            | "          | 1,253  | —          | 0·2    | —      |                                                  |
|               |            |        |            |        |        | April 13, 1864.                                  |
| 1             | 3          | 1,606  | —          | —      | 5·0    |                                                  |
| 2             | "          | 1,640  | —          | —      | 4·4    |                                                  |
| 3             | "          | 1,560  | —          | —      | 7·6    |                                                  |
| 4             | "          | 1,650  | —          | —      | 5·2    | The gun was 15 feet left of line.                |
| 5             | "          | 1,614  | —          | —      | 5·2    |                                                  |
| 6             | "          | 1,601  | —          | —      | 5·6    | Weather :—Slight haze on water at 10 a.m.        |
| 7             | "          | 1,641  | —          | —      | 4·6    | Clear, 3 p.m.                                    |
| 8             | "          | 1,641  | —          | —      | 5·2    |                                                  |
| 9             | "          | 1,638  | —          | —      | 5·6    | Wind :—Direction, S.E. by E. ; force 5 ; 10 a.m. |
| 10            | "          | 1,641  | —          | —      | 4·4    | " E. " 5 ; 3 p.m.                                |
| 11            | "          | 1,655  | —          | —      | 5·2    |                                                  |
| 12            | "          | 1,607  | —          | —      | 5·6    | Thermometer :—48 dry, 46 wet, 10 a.m.            |
| 13            | "          | 1,616  | —          | —      | 4·6    | 50 " 46 " 3 p.m.                                 |
| 14            | "          | 1,624  | —          | —      | 4·6    | Reading. Temperature.                            |
| 15            | "          | 1,668  | —          | —      | 4·4    | Barometer :—30·15 52 10 a.m.                     |
| 16            | "          | 1,630  | —          | —      | 5·2    | 30·10 54 3 p.m.                                  |
| 17            | "          | 1,642  | —          | —      | 5·6    |                                                  |
| 18            | "          | 1,610  | —          | —      | 5·2    |                                                  |
| 19            | "          | 1,602  | —          | —      | 5·4    |                                                  |
| 20            | "          | 1,636  | —          | —      | 4·0    |                                                  |
|               |            |        |            |        |        | April 14, 1864.                                  |
| 1             | 4          | 1,948  | —          | 8·0    | —      |                                                  |
| 2             | "          | 1,974  | —          | 6·8    | —      |                                                  |
| 3             | "          | 2,017  | —          | 8·0    | —      |                                                  |
| 4             | "          | 1,963  | —          | 7·2    | —      | The gun was 15 feet right of line.               |
| 5             | "          | 1,928  | —          | 8·4    | —      |                                                  |
| 6             | "          | 1,982  | —          | 8·2    | —      | Weather :—Very slight haze on water, 10 a.m.     |
| 7             | "          | 2,013  | —          | 9·0    | —      | Clear at 3 p.m.                                  |
| 8             | "          | 1,969  | —          | 6·8    | —      |                                                  |
| 9             | "          | 1,974  | —          | 7·0    | —      | Wind :—Direction, E. ; force, 4 ; 10 a.m.        |
| 10            | "          | 2,000  | —          | 7·4    | —      | " E. ; " 6 ; 3 p.m.                              |
| 11            | "          | 2,012  | —          | 8·0    | —      |                                                  |
| 12            | "          | 1,994  | —          | 6·2    | —      | Thermometer :—44 dry, 41 wet, 10 a.m.            |
| 13            | "          | 1,989  | —          | 9·0    | —      | 50 " 47 " 3 p.m.                                 |
| 14            | "          | 1,991  | —          | 7·4    | —      | Reading. Temperature.                            |
| 15            | "          | 1,910  | —          | 8·2    | —      | Barometer :—30·00 51 10 a.m.                     |
| 16            | "          | 2,010  | —          | 6·4    | —      | 30·05 59 3 p.m.                                  |
| 17            | "          | 2,014  | —          | 7·6    | —      |                                                  |
| 18            | "          | 2,000  | —          | 6·6    | —      |                                                  |
| 19            | "          | 1,998  | —          | 8·2    | —      |                                                  |
| 20            | "          | 1,999  | —          | 7·4    | —      |                                                  |



## RANGE AND ACCURACY.—SOLID SHOT—continued.

| No. of Round.   | Elevation. | Range. | 1st Graze. |        |        | Remarks.                                       |
|-----------------|------------|--------|------------|--------|--------|------------------------------------------------|
|                 |            |        | In Line.   | Right. | Left.  |                                                |
|                 | °          | Yards. |            | Yards. | Yards. |                                                |
| 1               | 5          | 2,046  | —          | —      | 2·4    | April 15, 1864.                                |
| 2               | "          | 2,312  | —          | 1·4    | —      |                                                |
| 3               | "          | 2,313  | —          | 0·8    | —      |                                                |
| 4               | "          | 2,312  | —          | 0·6    | —      |                                                |
| 5               | "          | 2,316  | —          | —      | 2·4    |                                                |
| 6               | "          | 2,346  | —          | 0·2    | —      | The gun was in the line.                       |
| 7               | "          | 2,308  | Yes.       | —      | —      | Weather:—Hazy.                                 |
| 8               | "          | 2,348  | —          | 1·4    | —      | Wind:—Direction, S.E. by S.; force, 3; 10 a.m. |
| 9               | "          | 2,305  | —          | 3·2    | —      | " " " 4; 3 p.m.                                |
| 10              | "          | 2,345  | —          | 1·8    | —      | Thermometer:—51 dry, 48 wet, 10 a.m.           |
| 11              | "          | 2,362  | —          | —      | 0·8    | 55 " 52 " 3 p.m.                               |
| 12              | "          | 2,357  | Yes.       | —      | —      |                                                |
| 13              | "          | 2,298  | —          | —      | 0·4    |                                                |
| 14              | "          | 2,364  | —          | 2·0    | —      |                                                |
| 15              | "          | 2,358  | Yes.       | —      | —      | Reading. Temperature.                          |
| 16              | "          | 2,340  | —          | 0·2    | —      | Barometer:—29·75 52 10 a.m.                    |
| 17              | "          | 2,313  | —          | 0·4    | —      | 29·75 56 3 p.m.                                |
| 18              | "          | 2,295  | —          | 2·0    | —      |                                                |
| 19              | "          | 2,354  | —          | —      | 0·2    |                                                |
| 20              | "          | 2,296  | —          | —      | 1·4    |                                                |
| April 15, 1864. |            |        |            |        |        |                                                |
| 1               | 6          | 2,641  | —          | —      | 0·2    |                                                |
| 2               | "          | 2,662  | —          | 0·2    | —      |                                                |
| 3               | "          | 2,654  | —          | —      | 2·2    |                                                |
| 4               | "          | 2,691  | Yes.       | —      | —      | The gun was in line.                           |
| 5               | "          | 2,693  | —          | 2·4    | —      | Weather:—Hazy.                                 |
| 6               | "          | 2,643  | —          | 0·4    | —      | Wind:—Direction, S.E. by S.; force, 3; 10 a.m. |
| 7               | "          | 2,637  | —          | 2·4    | —      | " " " 4; 3 p.m.                                |
| 8               | "          | 2,644  | —          | 7·0    | —      | Thermometer:—51 dry, 48 wet, 10 a.m.           |
| 9               | "          | 2,722  | —          | 3·0    | —      | 55 " 52 " 3 p.m.                               |
| 10              | "          | 2,682  | —          | —      | 0·4    |                                                |
| 11              | "          | 2,647  | —          | 2·0    | —      |                                                |
| 12              | "          | 2,645  | Yes.       | —      | —      |                                                |
| 13              | "          | 2,661  | Yes.       | —      | —      |                                                |
| 14              | "          | 2,653  | —          | 1·8    | —      | Reading. Temperature.                          |
| 15              | "          | 2,688  | —          | —      | 0·6    | Barometer:—29·75 52 10 a.m.                    |
| 16              | "          | 2,665  | —          | 2·4    | —      | 29·75 56 3 p.m.                                |
| 17              | "          | 2,650  | —          | 1·0    | —      |                                                |
| 18              | "          | 2,662  | —          | —      | 2·4    |                                                |
| 19              | "          | 2,692  | —          | —      | 0·8    |                                                |
| 20              | "          | 2,704  | —          | —      | 2·0    |                                                |
| April 15, 1864. |            |        |            |        |        |                                                |
| 1               | 7          | 3,004  | —          | 0·6    | —      |                                                |
| 2               | "          | 3,016  | —          | 6·2    | —      |                                                |
| 3               | "          | 2,989  | —          | 2·6    | —      |                                                |
| 4               | "          | 2,996  | —          | 3·6    | —      | The gun was in line.                           |
| 5               | "          | 2,040  | —          | 1·2    | —      | Weather:—Hazy.                                 |
| 6               | "          | 2,998  | —          | —      | 0·2    | Wind:—Direction, S.E. by S.; force, 3; 10 a.m. |
| 7               | "          | 2,997  | —          | —      | 1·8    | " " " 4; 3 p.m.                                |
| 8               | "          | 3,015  | —          | 0·4    | —      | Thermometer:—51 dry, 48 wet, 10 a.m.           |
| 9               | "          | 2,996  | Yes.       | —      | —      | 55 " 52 " 3 p.m.                               |
| 10              | "          | 3,015  | —          | 1·4    | —      |                                                |
| 11              | "          | 3,020  | —          | —      | 5·0    |                                                |
| 12              | "          | 3,048  | —          | 1·6    | —      |                                                |
| 13              | "          | 3,050  | —          | 1·0    | —      |                                                |
| 14              | "          | 3,002  | —          | —      | 3·8    | Reading. Temperature.                          |
| 15              | "          | 3,070  | —          | —      | 3·6    | Barometer:—29·75 52 10 a.m.                    |
| 16              | "          | 3,064  | —          | —      | 1·6    | 29·75 56 3 p.m.                                |
| 17              | "          | 3,040  | —          | 2·8    | —      |                                                |
| 18              | "          | 3,048  | —          | —      | 0·6    |                                                |
| 19              | "          | 3,064  | —          | 1·0    | —      |                                                |
| 20              | "          | 3,001  | —          | 1·8    | —      |                                                |

## RANGE AND ACCURACY.—SOLID SHOT—continued.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | In Line.   | Right. | Left.  |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
|               | °            | Yards. |            | Yards. | Yards. |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 1             | 8            | 3,348  | —          | 10·6   | —      | <i>April 25, 1864.</i><br><br>The gun was in line.<br>Weather:—Clear.<br>Wind:—Direction, E. ; force, 4 ; 10 a.m.<br>" E.S.E. ; " 3 ; 3 p.m.<br>Thermometer:—51 dry, 48 wet, 10 a.m.<br>52 " 50 " 3 p.m.<br>Barometer:— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·20</td><td>52</td></tr><tr><td>30·15</td><td>55</td></tr></table> 10 a.m.<br>3 p.m.     | Reading. | Temperature. | 30·20 | 52 | 30·15 | 55 |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 30·20         | 52           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 30·15         | 55           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 2             | "            | 3,329  | —          | 12·8   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 3             | "            | 3,282  | —          | 9·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 4             | "            | 3,338  | —          | 5·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 5             | "            | 3,316  | —          | 10·8   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 6             | "            | 3,327  | —          | 6·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 7             | "            | 3,323  | —          | 9·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 8             | "            | 3,350  | —          | 8·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 9             | "            | 3,351  | —          | 11·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 10            | "            | 3,324  | —          | 3·6    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 11            | "            | 3,326  | —          | 9·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 12            | "            | 3,336  | —          | 8·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 13            | "            | 3,296  | —          | 9·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 14            | "            | 3,329  | —          | 7·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 15            | "            | 3,255  | —          | 4·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 16            | "            | 3,307  | —          | 5·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 17            | "            | 3,266  | —          | 11·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 18            | "            | 3,355  | —          | 6·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 19            | "            | 3,318  | —          | 9·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 20            | "            | 3,360  | —          | 6·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
|               |              |        |            |        |        | <i>April 26, 1864.</i>                                                                                                                                                                                                                                                                                                                                                           |          |              |       |    |       |    |
| 1             | 9            | 3,642  | —          | —      | 20·4   | The gun was in line.<br>Weather:—Hazy, 10 a.m.<br>Clear, 3 p.m.<br>Wind:—Direction, N.E. by E. ; force, 1 ; 10 a.m.<br>" E. by S. ; " 2 ; 3 p.m.<br>Thermometer:—52 dry, 49 wet, 10 a.m.<br>52 " 49 " 3 p.m.<br>Barometer:— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·20</td><td>52</td></tr><tr><td>30·35</td><td>53</td></tr></table> 10 a.m.<br>3 p.m. | Reading. | Temperature. | 30·20 | 52 | 30·35 | 53 |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 30·20         | 52           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 30·35         | 53           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 2             | "            | 3,647  | —          | —      | 23·4   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 3             | "            | 3,698  | —          | —      | 19·0   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 4             | "            | 3,646  | —          | —      | 20·2   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 5             | "            | 3,686  | —          | —      | 23·0   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 6             | "            | 3,660  | —          | —      | 17·0   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 7             | "            | 3,636  | —          | —      | 22·0   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 8             | "            | 3,632  | —          | —      | 23·4   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 9             | "            | 3,682  | —          | —      | 23·0   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 10            | "            | 3,684  | —          | —      | 24·0   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 11            | "            | 3,632  | —          | —      | 24·8   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 12            | "            | 3,596  | —          | —      | 25·4   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 13            | "            | 3,654  | —          | —      | 23·4   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 14            | "            | 3,680  | —          | —      | 22·2   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 15            | "            | 3,656  | —          | —      | 18·6   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 16            | "            | 3,671  | —          | —      | 19·0   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 17            | "            | 3,607  | —          | —      | 22·4   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 18            | "            | 3,668  | —          | —      | 22·4   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 19            | "            | 3,638  | —          | —      | 25·0   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 20            | "            | 3,633  | —          | —      | 24·4   |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
|               |              |        |            |        |        | <i>April 27, 1864.</i>                                                                                                                                                                                                                                                                                                                                                           |          |              |       |    |       |    |
| 1             | 10           | 3,940  | —          | 15·6   | —      | The gun was in line.<br>Weather:—Hazy, 10 a.m.<br>Slight haze, 3 p.m.<br>Wind:—Direction, E. ; force, 3 ; 10 a.m.<br>" E.S.E. ; " 4 ; 3 p.m.<br>Thermometer:—49 dry, 47 wet, 10 a.m.<br>50 " 48 " 3 p.m.<br>Barometer:— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·20</td><td>51</td></tr><tr><td>30·20</td><td>53</td></tr></table> 10 a.m.<br>3 p.m.     | Reading. | Temperature. | 30·20 | 51 | 30·20 | 53 |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 30·20         | 51           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 30·20         | 53           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 2             | "            | 3,998  | —          | 17·6   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 3             | "            | 3,917  | —          | 25·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 4             | "            | 3,900  | —          | 21·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 5             | "            | 3,963  | —          | 10·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 6             | "            | 3,959  | —          | 11·8   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 7             | "            | 3,942  | —          | 13·6   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 8             | "            | 3,921  | —          | 13·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 9             | "            | 3,884  | —          | 14·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 10            | "            | 3,919  | —          | 17·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 11            | "            | 3,883  | —          | 16·8   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 12            | "            | 3,910  | —          | 20·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 13            | "            | 3,900  | —          | 19·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 14            | "            | 3,917  | —          | 13·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 15            | "            | 3,908  | —          | 10·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 16            | "            | 3,933  | —          | 10·6   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 17            | "            | 3,945  | —          | 15·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 18            | "            | 3,897  | —          | 17·6   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 19            | "            | 3,909  | —          | 18·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 20            | "            | 3,886  | —          | 11·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |





## RANGE AND ACCURACY—continued.

## SHOT.

| No. of Round. | Elevation. | Range. | 1st Graze. |        |        | Remarks.                                                                  |
|---------------|------------|--------|------------|--------|--------|---------------------------------------------------------------------------|
|               |            |        | In Line.   | Right. | Left.  |                                                                           |
|               | °          | Yards. |            | Yards. | Yards. | <i>March 7, 1865.</i>                                                     |
| 1             | 5          | 2,343  | —          | —      | 1.0    |                                                                           |
| 2             | "          | 2,357  | Yes.       | —      | —      |                                                                           |
| 3             | "          | 2,325  | —          | 1.8    | —      |                                                                           |
| 4             | "          | 2,377  | —          | 0.2    | —      |                                                                           |
| 5             | "          | 2,403  | —          | —      | 1.4    | Without lubricators.                                                      |
| 6             | "          | 2,415  | —          | —      | 1.6    |                                                                           |
| 7             | "          | 2,410  | —          | —      | 1.6    | Weather :—Slight haze.                                                    |
| 8             | "          | 2,359  | —          | —      | 1.0    |                                                                           |
| 9             | "          | 2,356  | —          | —      | 1.8    | Wind :—Direction, N. ; force, 3; 10 a.m.                                  |
| 10            | "          | 2,351  | —          | 0.4    | —      | „ N.N.W. ; „ 3; 3 p.m.                                                    |
| 11            | "          | 2,321  | —          | 0.8    | —      |                                                                           |
| 12            | "          | 2,368  | —          | —      | 0.4    | Thermometer :—38 dry, 38 wet, 10 a.m.                                     |
| 13            | "          | 2,269  | —          | —      | 1.2    | 44 „ 42 „ 3 p.m.                                                          |
| 14            | "          | 2,382  | —          | —      | 1.4    |                                                                           |
| 15            | "          | 2,381  | —          | —      | 3.0    | Barometer :— <sup>Reading.</sup> 29.57 <sup>Temperature.</sup> 42 10 a.m. |
| 16            | "          | 2,331  | —          | —      | 1.0    | 29.60 45 3 p.m.                                                           |
| 17            | "          | 2,416  | —          | —      | 1.6    |                                                                           |
| 18            | "          | 2,297  | —          | —      | 1.4    |                                                                           |
| 19            | "          | 2,371  | Yes.       | —      | —      |                                                                           |
| 20            | "          | 2,301  | —          | —      | 2.8    |                                                                           |
| 21            | "          | 2,387  | —          | 0.4    | —      |                                                                           |
| 22            | "          | 2,406  | —          | —      | 1.0    |                                                                           |



## RANGE AND ACCURACY—continued.

## COMMON SHELL (weighted with sand).

SHOEBURYNESS.

## Particulars of Shell and Ammunition.

Weight, 11 lbs. 10<sup>8</sup>/<sub>8</sub> oz.  
 Length, 10<sup>8</sup>/<sub>8</sub> in.  
 Bursting charge, 8<sup>1</sup>/<sub>2</sub> oz.  
 Length of cartridge, 10<sup>5</sup>/<sub>5</sub> in.  
 Diameter of ditto, 2<sup>5</sup>/<sub>7</sub> in.

Charge, 1<sup>3</sup>/<sub>4</sub> lbs.  
 Brand of powder, A4.  
 Wad, Boxer's lubricator filled with oil;  
 brush sponge.

| No. of Round. | Elevation. | Range. | 1st Graze. |        | 2nd Graze. |        | 3rd Graze. |        | Remarks.                                                                                                                                                    |
|---------------|------------|--------|------------|--------|------------|--------|------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |            |        | Right.     | Left.  | Range.     | Right. | Range.     | Right. |                                                                                                                                                             |
|               | °          | Yards. | Yards.     | Yards. | Yards.     | Yards. | Yards.     | Yards. | <i>April 4, 1864.</i>                                                                                                                                       |
| 1             | 0          | 503    | 0.4        | —      | 2,056      | 37.6   | 3,400      | 112    | The gun was placed in line.<br>Weather :—Hazy at 10 a.m. Slight haze at 3 p.m.<br>Wind :—Direction, S.E. by E.; force, 1; 10 a.m.<br>" " N.N.W. " 1; 3 p.m. |
| 2             | 0          | 505    | 0.4        | —      | 2,003      | 1.6    | 3,748      | 88     | Thermometer :—48 dry, 47 wet, 10 a.m.<br>60 " 58 " 3 p.m.                                                                                                   |
| 3             | 0          | 529    | —          | 0.4    | 1,476      | 16.0   | 2,846      | 18     | Reading. Temperature.<br>Barometer :—29.75 50 10 a.m.<br>29.95 62 3 p.m.                                                                                    |

| No. of Round. | Elevation. | Range. | 1st Graze. |        |        | Remarks.                                                  |
|---------------|------------|--------|------------|--------|--------|-----------------------------------------------------------|
|               |            |        | In Line.   | Right. | Left.  |                                                           |
|               | °          | Yards. |            | Yards. | Yards. | <i>April 27, 1864.</i>                                    |
| 1             | 0          | 534    | —          | —      | 0.2    | The gun was in line.                                      |
| 2             | "          | 523    | —          | —      | 0.4    | Weather { Hazy, 10 a.m.<br>Slight haze, 3 p.m.            |
| 3             | "          | 540    | —          | —      | 0.4    | Wind :—Direction, E.; force, 3; 10 a.m.                   |
| 4             | "          | 539    | —          | —      | 0.6    | " E.S.E.; " 4; 3 p.m.                                     |
| 5             | "          | 546    | —          | —      | 0.2    | Thermometer :—49 dry, 47 wet, 10 a.m.<br>50 " 48 " 3 p.m. |
|               |            |        |            |        |        | <i>April 27, 1864.</i>                                    |
| 1             | 1          | 938    | —          | —      | 0.4    | The gun was in line.                                      |
| 2             | "          | 956    | —          | —      | 0.2    | Reading. Temperature.                                     |
| 3             | "          | 927    | —          | —      | 0.4    | Barometer :—30.20 51 10 a.m.                              |
| 4             | "          | 914    | —          | —      | 0.2    | 30.20 53 3 p.m.                                           |
| 5             | "          | 906    | —          | 0.2    | —      |                                                           |
|               |            |        |            |        |        | <i>April 11, 1864.</i>                                    |
| 1             | 2          | 1,290  | —          | 0.4    | —      | The gun was in line.                                      |
| 2             | "          | 1,260  | Yes.       | —      | —      | Weather :—Very thick haze.                                |
| 3             | "          | 1,285  | Yes.       | —      | —      | Wind :—Direction, W.N.W.; force nil; 10 a.m.              |
| 4             | "          | 1,273  | —          | 0.2    | —      | " W.S.W.; " 1; 3 p.m.                                     |
| 5             | "          | 1,190  | —          | 0.6    | —      | Thermometer :—47 dry, 45 wet, 10 a.m.<br>50 " 51 " 3 p.m. |
|               |            |        |            |        |        | Reading. Temperature.                                     |
|               |            |        |            |        |        | Barometer :—30.10 52 10 a.m.                              |
|               |            |        |            |        |        | 30.05 54 3 p.m.                                           |
|               |            |        |            |        |        | <i>April 14, 1864.</i>                                    |
| 1             | 3          | 1,625  | —          | 6.0    | —      | The gun was 15 feet right of line.                        |
| 2             | "          | 1,612  | —          | 5.0    | —      | Weather :—Very slight haze on water, 10 a.m.              |
| 3             | "          | 1,626  | —          | 6.2    | —      | Clear at 3 p.m.                                           |
| 4             | "          | 1,650  | —          | 5.0    | —      |                                                           |
| 5             | "          | 1,603  | —          | 6.8    | —      |                                                           |

RANGE AND ACCURACY.—COMMON SHELL—*continued.*

| No. of Round.   | Elevation. | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                                                                                                                                                |
|-----------------|------------|--------|------------|--------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                 |            |        | In Line.   | Right. | Left.  |                                                                                                                                                                                                                                                                                         |
|                 | °          | Yards. |            | Yards. | Yards. |                                                                                                                                                                                                                                                                                         |
| April 14, 1864. |            |        |            |        |        |                                                                                                                                                                                                                                                                                         |
| 1               | 4          | 1,990  | —          | 6·2    | —      | The gun was 15 feet to right of line.<br>Wind :—Direction, E.; force, 4; 10 a.m.<br>" E.; " 6; 3 p.m.                                                                                                                                                                                   |
| 2               | "          | 1,944  | —          | 6·0    | —      |                                                                                                                                                                                                                                                                                         |
| 3               | "          | 2,006  | —          | 7·0    | —      |                                                                                                                                                                                                                                                                                         |
| 4               | "          | 1,941  | —          | 7·0    | —      |                                                                                                                                                                                                                                                                                         |
| 5               | "          | 1,944  | —          | 12·6   | —      |                                                                                                                                                                                                                                                                                         |
| April 14, 1864. |            |        |            |        |        |                                                                                                                                                                                                                                                                                         |
| 1               | 5          | 2,218  | —          | 6·4    | —      | The gun was 15 feet to right of line.<br>Thermometer :—44 dry, 41 wet, 10 a.m.<br>50 " 47 " 3 p.m.<br>Reading. Temperature.<br>Barometer :—30·00 51 10 a.m.<br>30·05 59 3 p.m.                                                                                                          |
| 2               | "          | 2,208  | —          | 7·6    | —      |                                                                                                                                                                                                                                                                                         |
| 3               | "          | 2,261  | —          | —      | 14·0   |                                                                                                                                                                                                                                                                                         |
| 4               | "          | 2,248  | —          | 7·0    | —      |                                                                                                                                                                                                                                                                                         |
| 5               | "          | 2,130  | —          | 13·2   | —      |                                                                                                                                                                                                                                                                                         |
| April 15, 1864. |            |        |            |        |        |                                                                                                                                                                                                                                                                                         |
| 1               | 6          | 2,649  | —          | 2·0    | —      | The gun was in the line.<br>Weather :—Hazy.<br>Wind :—Direction, S.E. by S.; force, 3; 10 a.m.<br>" " " 4; 3 p.m.                                                                                                                                                                       |
| 2               | "          | 2,653  | —          | —      | 0·4    |                                                                                                                                                                                                                                                                                         |
| 3               | "          | 2,604  | —          | —      | 5·0    |                                                                                                                                                                                                                                                                                         |
| 4               | "          | 2,652  | —          | —      | 7·2    |                                                                                                                                                                                                                                                                                         |
| 5               | "          | 2,693  | —          | —      | 3·2    |                                                                                                                                                                                                                                                                                         |
| April 15, 1864. |            |        |            |        |        |                                                                                                                                                                                                                                                                                         |
| 1               | 7          | 2,914  | —          | —      | 8·0    | The gun was in line.<br>Thermometer :—51 dry, 48 wet, 10 a.m.<br>55 " 52 " 3 p.m.<br>Reading. Temperature.<br>Barometer :—29·75 52 10 a.m.<br>29·75 56 3 p.m.                                                                                                                           |
| 2               | "          | 2,959  | —          | —      | 7·8    |                                                                                                                                                                                                                                                                                         |
| 3               | "          | 2,997  | —          | —      | 2·2    |                                                                                                                                                                                                                                                                                         |
| 4               | "          | 3,072  | —          | —      | 8·4    |                                                                                                                                                                                                                                                                                         |
| 5               | "          | 3,055  | —          | —      | 4·8    |                                                                                                                                                                                                                                                                                         |
| April 25, 1864. |            |        |            |        |        |                                                                                                                                                                                                                                                                                         |
| 1               | 8          | 3,259  | —          | 2·6    | —      | The gun was in line.<br>Weather :—Clear.<br>Wind :—Direction, E.; force, 4 at 10 a.m.<br>" E.S.E.; " 3 at 3 p.m.<br>Thermometer :—51 dry, 48 wet, 10 a.m.<br>52 " 50 " 3 p.m.<br>Reading. Temperature.<br>Barometer :—30·20 52 10 a.m.<br>30·15 55 3 p.m.                               |
| 2               | "          | 3,169  | —          | 6·4    | —      |                                                                                                                                                                                                                                                                                         |
| 3               | "          | 3,274  | —          | 4·8    | —      |                                                                                                                                                                                                                                                                                         |
| 4               | "          | 3,246  | —          | 5·0    | —      |                                                                                                                                                                                                                                                                                         |
| 5               | "          | 3,289  | —          | 2·8    | —      |                                                                                                                                                                                                                                                                                         |
| April 26, 1864. |            |        |            |        |        |                                                                                                                                                                                                                                                                                         |
| 1               | 9          | 3,494  | —          | —      | 26·0   | The gun was in line.<br>Weather :—Hazy, 10 a.m.<br>Clear, 3 p.m.<br>Wind :—Direction, N.E. by E.; force, 1; 10 a.m.<br>" E. by S.; " 2; 3 p.m.<br>Thermometer :—52 dry, 49 wet, 10 a.m.<br>52 " 49 " 3 p.m.<br>Reading. Temperature.<br>Barometer :—30·20 52 10 a.m.<br>30·35 53 3 p.m. |
| 2               | "          | 3,670  | —          | —      | 21·0   |                                                                                                                                                                                                                                                                                         |
| 3               | "          | 3,687  | —          | —      | 27·0   |                                                                                                                                                                                                                                                                                         |
| 4               | "          | 3,477  | —          | —      | 31·4   |                                                                                                                                                                                                                                                                                         |
| 5               | "          | 3,605  | —          | —      | 31·0   |                                                                                                                                                                                                                                                                                         |
| April 27, 1864. |            |        |            |        |        |                                                                                                                                                                                                                                                                                         |
| 1               | 10         | 3,756  | —          | 22·4   | —      | The gun was in line.<br>Weather :—Hazy, 10 a.m.<br>Slight haze, 3 p.m.<br>For weather, see 0°.                                                                                                                                                                                          |
| 2               | "          | 3,796  | —          | 8·8    | —      |                                                                                                                                                                                                                                                                                         |
| 3               | "          | 3,870  | —          | 16·2   | —      |                                                                                                                                                                                                                                                                                         |
| 4               | "          | 3,930  | —          | 9·2    | —      |                                                                                                                                                                                                                                                                                         |
| 5               | "          | 3,852  | —          | 21·6   | —      |                                                                                                                                                                                                                                                                                         |



RANGE AND ACCURACY—*continued.*

## SHRAPNEL SHELL (BOXER'S), (weighted with burster).

SHOEBURYNNESS.

*Particulars, &c. of Shell and Ammunition.*

Weight, 11 lbs. 14·4 oz.  
 Length, 8·95 inches.  
 Number of bullets, 35.  
 " segments, 14.  
 Bursting charge, 3 or 6 drs.  
 Length of cartridge, 10½ in.

Diameter of cartridge, 2·57 in.  
 Brand of powder, A4 powder.  
 Charge, 1¼ lbs.  
 Wad, Boxer's lubricator filled with oil.  
 Dry brush sponge.

| No. of Round. | Elevation. | Range. | 1st Graze. |        | 2nd Graze. |        | 3rd Graze. |        | Remarks.                                       |
|---------------|------------|--------|------------|--------|------------|--------|------------|--------|------------------------------------------------|
|               |            |        | In Line.   | Right. | Range.     | Right. | Range.     | Right. |                                                |
|               | °          | Yards. |            | Yards. | Yards.     | Yards. | Yards.     | Yards. | <i>April 4, 1864.</i>                          |
| 1             | 0          | 497    | Yes.       | —      | Not seen.  | —      | 3,800      | 170    | The gun was in the line.                       |
| 2             | "          | 487    | —          | 0·4    | 1,746      | 28     | 3,154      | 84     | Weather:—Hazy at 10 a.m.                       |
| 3             | "          | 503    | Yes.       | —      | Not seen.  | —      | —          | —      | Slight haze at 3 p.m.                          |
| 4             | "          | 518    | —          | 0·4    | 2,409      | 56     | 3,776      | 20     | Wind:—Direction, S.E. by E.; force, 1; 10 a.m. |
| 5             | "          | 523    | —          | 0·4    | 1,994      | 34·2   | 2,900      | 52     | " N.N.W. " 1; 3 p.m.                           |
|               |            |        |            |        |            |        |            |        | Thermometer:—48 dry, 47 wet, 10 a.m.           |
|               |            |        |            |        |            |        |            |        | 60 " 58 " 3 p.m.                               |
|               |            |        |            |        |            |        |            |        | Barometer:—29·75 50 10 a.m.                    |
|               |            |        |            |        |            |        |            |        | 29·95 62 3 p.m.                                |

| No. of Round. | Elevation. | Range. | 1st Graze. |        |        | Remarks.                                     |
|---------------|------------|--------|------------|--------|--------|----------------------------------------------|
|               |            |        | In Line.   | Right. | Left.  |                                              |
|               | °          | Yards. |            | Yards. | Yards. | <i>April 27, 1864.</i>                       |
| 1             | 1          | 935    | —          | —      | 0·4    | The gun was in line.                         |
| 2             | "          | 885    | —          | 0·4    | —      | Weather:—Hazy, 10 a.m.                       |
| 3             | "          | 926    | —          | —      | 1·0    | Slight haze, 3 p.m.                          |
| 4             | "          | 888    | —          | —      | 1·4    | Wind:—Direction, E; force, 3; 10 a.m.        |
| 5             | "          | 913    | —          | 1·0    | —      | " E.S.E. " 4; 3 p.m.                         |
|               |            |        |            |        |        | Thermometer:—49 dry, 47 wet, 10 a.m.         |
|               |            |        |            |        |        | 50 " 48 " 3 p.m.                             |
|               |            |        |            |        |        | Barometer:—30·20 51 10 a.m.                  |
|               |            |        |            |        |        | 30·20 53 3 p.m.                              |
|               |            |        |            |        |        | <i>April 11, 1864.</i>                       |
| 1             | 2          | 1,235  | —          | 0·8    | —      | The gun was in line.                         |
| 2             | "          | 1,278  | —          | 1·8    | —      | Weather:—Very thick haze.                    |
| 3             | "          | 1,256  | —          | 1·0    | —      | Wind:—Direction, W.N.W.; force, nil; 10 a.m. |
| 4             | "          | 1,272  | —          | —      | 0·2    | " W.S.W. " 1; 3 p.m.                         |
| 5             | "          | 1,303  | —          | 1·2    | —      | Thermometer:—47 dry, 45 wet, 10 a.m.         |
|               |            |        |            |        |        | 50 " 51 " 3 p.m.                             |
|               |            |        |            |        |        | Barometer:—30·10 52 10 a.m.                  |
|               |            |        |            |        |        | 30·05 54 3 p.m.                              |
|               |            |        |            |        |        | <i>April 14, 1864.</i>                       |
| 1             | 3          | 1,656  | —          | 6·0    | —      | The gun was 15 feet right of line.           |
| 2             | "          | 1,653  | —          | 6·0    | —      | Weather:—Very slight haze on water, 10 a.m.  |
| 3             | "          | 1,597  | —          | 6·6    | —      | Clear at 3 p.m.                              |
| 4             | "          | 1,602  | —          | 6·8    | —      | Wind:—Direction, E.; force, 4; 10 a.m.       |
| 5             | "          | 1,614  | —          | 6·2    | —      | " E. " 6; 3 p.m.                             |

RANGE AND ACCURACY.—SHRAPNEL SHELL—*continued.*

| No. of Round.                            | Elevation. | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                                                                    |
|------------------------------------------|------------|--------|------------|--------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                          |            |        | In Line.   | Right. | Left.  |                                                                                                                                                                                                             |
|                                          | °          | Yards. |            | Yards. | Yards. |                                                                                                                                                                                                             |
| April 14, 1864.                          |            |        |            |        |        |                                                                                                                                                                                                             |
| 1                                        | 4          | 1,944  | —          | 10·0   | —      | The gun was 15 feet right of line.<br>Thermometer :—44 dry, 41 wet, 10 a.m.<br>50 „ 47 „ 3 p.m.                                                                                                             |
| 2                                        | „          | 1,962  | —          | 8·2    | —      |                                                                                                                                                                                                             |
| 3                                        | „          | 1,969  | —          | 7·6    | —      |                                                                                                                                                                                                             |
| 4                                        | „          | 1,972  | —          | 8·0    | —      |                                                                                                                                                                                                             |
| 5                                        | „          | 1,964  | —          | 5·6    | —      |                                                                                                                                                                                                             |
| April 14, 1864.                          |            |        |            |        |        |                                                                                                                                                                                                             |
| 1                                        | 5          | 2,256  | —          | 10·0   | —      | The gun was 15 feet to right of line.<br>Reading. Temperature.<br>Barometer :—30·00 51 10 a.m.<br>30·05 59 3 p.m.                                                                                           |
| 2                                        | „          | 2,246  | —          | 9·6    | —      |                                                                                                                                                                                                             |
| 3                                        | „          | 2,220  | —          | 9·2    | —      |                                                                                                                                                                                                             |
| 4                                        | „          | 2,290  | —          | 9·4    | —      |                                                                                                                                                                                                             |
| 5                                        | „          | 2,200  | —          | 10·0   | —      |                                                                                                                                                                                                             |
| April 15, 1864.                          |            |        |            |        |        |                                                                                                                                                                                                             |
| 1                                        | 6          | 2,658  | —          | —      | 0·4    | The gun was in line.<br>Weather :—Hazy.<br>Wind :—Direction, S.E. by S. ; force, 3 ; 10 a.m.<br>„ „ „ 4 ; 3 p.m.                                                                                            |
| 2                                        | „          | 2,667  | —          | —      | 1·4    |                                                                                                                                                                                                             |
| 3                                        | „          | 2,654  | Yes.       | —      | —      |                                                                                                                                                                                                             |
| 4                                        | „          | 2,701  | —          | 2·0    | —      |                                                                                                                                                                                                             |
| 5                                        | „          | 2,689  | —          | 3·2    | —      |                                                                                                                                                                                                             |
| April 15, 1864.                          |            |        |            |        |        |                                                                                                                                                                                                             |
| 1                                        | 7          | 3,062  | —          | 5·2    | —      | The gun was in line.<br>Thermometer :—51 dry, 48 wet, 10 a.m.<br>55 „ 52 „ 3 p.m.<br>Reading. Temperature.<br>Barometer :—29·75 52 10 a.m.<br>29·75 56 3 p.m.                                               |
| 2                                        | „          | 3,032  | —          | —      | 1·2    |                                                                                                                                                                                                             |
| 3                                        | „          | 3,047  | —          | —      | 1·2    |                                                                                                                                                                                                             |
| 4                                        | „          | 2,856  | —          | —      | 0·2    |                                                                                                                                                                                                             |
| 5                                        | „          | 3,044  | —          | —      | 3·8    |                                                                                                                                                                                                             |
| April 25, 1864.                          |            |        |            |        |        |                                                                                                                                                                                                             |
| The gun was in line.<br>Weather :—Clear. |            |        |            |        |        |                                                                                                                                                                                                             |
| 1                                        | 8          | 3,254  | —          | 9·4    | —      | Wind :—Direction, E. ; force, 4 ; 10 a.m.<br>„ E.S.E. „ 3 ; 3 p.m.<br>Thermometer :—51 dry, 48 wet, 10 a.m.<br>52 „ 50 „ 3 p.m.<br>Reading. Temperature.<br>Barometer :—30·20 52 10 a.m.<br>30·15 55 3 p.m. |
| 2                                        | „          | 3,209  | —          | 13·2   | —      |                                                                                                                                                                                                             |
| 3                                        | „          | 3,280  | —          | 6·4    | —      |                                                                                                                                                                                                             |
| 4                                        | „          | 3,355  | —          | 11·2   | —      |                                                                                                                                                                                                             |
| 5                                        | „          | 3,278  | —          | 4·4    | —      |                                                                                                                                                                                                             |
| April 26, 1864.                          |            |        |            |        |        |                                                                                                                                                                                                             |
| 1                                        | 9          | 3,482  | —          | —      | 28·0   | The gun was in line.<br>Weather :—Hazy, 10 a.m.<br>Clear, 3 p.m.<br>Wind :—Direction, N.E. by E. ; force, 1 ; 10 a.m.<br>„ E. by S. „ 2 ; 3 p.m.                                                            |
| 2                                        | „          | 3,522  | —          | —      | 21·0   |                                                                                                                                                                                                             |
| 3                                        | „          | 3,593  | —          | —      | 24·2   |                                                                                                                                                                                                             |
| 4                                        | „          | 3,566  | —          | —      | 25·8   |                                                                                                                                                                                                             |
| 5                                        | „          | 3,522  | —          | —      | 26·6   |                                                                                                                                                                                                             |
| April 26, 1864.                          |            |        |            |        |        |                                                                                                                                                                                                             |
| 1                                        | 10         | 4,039  | —          | —      | 31·0   | The gun was in line.<br>Thermometer :—52 dry, 49 wet, 10 a.m.<br>52 „ 49 „ 3 p.m.<br>Reading. Temperature.<br>Barometer :—30·20 52 10 a.m.<br>30·35 53 3 p.m.                                               |
| 2                                        | „          | 3,892  | —          | —      | 30·0   |                                                                                                                                                                                                             |
| 3                                        | „          | 3,757  | —          | —      | 30·0   |                                                                                                                                                                                                             |
| 4                                        | „          | 3,940  | —          | —      | 32·0   |                                                                                                                                                                                                             |
| 5                                        | „          | 4,054  | —          | —      | 33·0   |                                                                                                                                                                                                             |



## SHRAPNEL SHELL—continued.

| No. of Round.      | Elevation. | Range.        | 1st Graze. |             |               | Remarks.                                                                  |
|--------------------|------------|---------------|------------|-------------|---------------|---------------------------------------------------------------------------|
|                    |            |               | In Line.   | Right.      | Left.         |                                                                           |
| February 22, 1865. |            |               |            |             |               |                                                                           |
| 1                  | 0          | Yards.<br>541 | —          | Yards.<br>— | Yards.<br>7.2 | This gun was 15 feet left of line.                                        |
| 2                  | "          | 488           | —          | —           | 6.6           |                                                                           |
| 3                  | "          | 500           | —          | —           | 7.2           | Weather :—Thick haze on water.                                            |
| 4                  | "          | 508           | —          | —           | 7.6           | Wind :—Direction, W. ; force, 2 ; 10 a.m.                                 |
| 5                  | "          | 558           | —          | —           | 6.0           | " S.W. by W. ; force, 1 ; 3 p.m.                                          |
| 6                  | "          | 515           | —          | —           | 6.0           |                                                                           |
| 7                  | "          | 525           | —          | —           | 6.0           |                                                                           |
| 8                  | "          | 522           | —          | —           | 6.0           |                                                                           |
| 9                  | "          | 512           | —          | —           | 6.4           |                                                                           |
| 10                 | "          | —             | —          | —           | —             | Broke up at muzzle.                                                       |
| 11                 | "          | —             | —          | —           | —             | Broke up at muzzle.                                                       |
| 12                 | "          | 553           | —          | —           | 6.0           | Thermometer :—36 dry, 35 wet, 10 a.m.                                     |
| 13                 | "          | 511           | —          | —           | 8.0           |                                                                           |
| 14                 | "          | 508           | —          | —           | 6.2           | 39 " 38 " 3 p.m.                                                          |
| 15                 | "          | 511           | —          | —           | 6.4           | Barometer :— <sup>Reading.</sup> 30.27 <sup>Temperature.</sup> 38 10 a.m. |
| 16                 | "          | 516           | —          | —           | 6.8           |                                                                           |
| 17                 | "          | 535           | —          | —           | 6.0           | 30.25 41 3 p.m.                                                           |
| 18                 | "          | 536           | —          | —           | 7.2           |                                                                           |
| 19                 | "          | —             | —          | —           | —             | Broke up at muzzle.                                                       |
| 20                 | "          | —             | —          | —           | —             | Broke up at muzzle.                                                       |
| 21                 | "          | 528           | —          | —           | 6.4           |                                                                           |
| 22                 | "          | 527           | —          | —           | 5.4           |                                                                           |
| 1                  | 3          | 1,585         | —          | —           | 12.6          |                                                                           |
| 2                  | "          | 1,546         | —          | —           | 9.0           |                                                                           |
| 3                  | "          | 1,556         | —          | —           | 10.8          |                                                                           |
| 4                  | "          | 1,512         | —          | —           | 11.2          |                                                                           |
| 5                  | "          | 1,548         | —          | —           | 11.0          |                                                                           |
| 6                  | "          | 1,509         | —          | —           | 9.6           |                                                                           |
| 7                  | "          | 1,556         | —          | —           | 12.0          |                                                                           |
| 8                  | "          | 1,606         | —          | —           | 10.8          |                                                                           |
| 9                  | "          | 1,566         | —          | —           | 10.0          |                                                                           |
| 10                 | "          | 1,572         | —          | —           | 16.4          | Broke up on graze.                                                        |
| 11                 | "          | 1,523         | —          | —           | 7.6           |                                                                           |
| 12                 | "          | 1,606         | —          | —           | 10.0          | Broke up on graze.                                                        |
| 13                 | "          | 1,581         | —          | —           | 16.0          |                                                                           |
| 14                 | "          | 1,551         | —          | —           | 11.6          |                                                                           |
| 15                 | "          | 1,605         | —          | —           | 12.0          |                                                                           |
| 16                 | "          | —             | —          | —           | —             | Broke up at the muzzle.                                                   |
| 17                 | "          | 1,559         | —          | —           | 10.4          |                                                                           |
| 18                 | "          | 1,500         | —          | —           | 10.1          |                                                                           |
| 19                 | "          | —             | —          | —           | —             | Broke up at muzzle.                                                       |
| 20                 | "          | 1,515         | —          | —           | 11.0          |                                                                           |
| 21                 | "          | 1,546         | —          | —           | 11.2          |                                                                           |
| 22                 | "          | 1,616         | —          | —           | 12.0          |                                                                           |
| 1                  | 5          | —             | —          | —           | —             | Broke up at muzzle.                                                       |
| 2                  | "          | 2,291         | —          | —           | 12.4          |                                                                           |
| 3                  | "          | 2,316         | —          | —           | 15.0          |                                                                           |
| 4                  | "          | 2,275         | —          | —           | 21.4          |                                                                           |
| 5                  | "          | 2,291         | —          | —           | 11.4          |                                                                           |
| 6                  | "          | 2,100         | —          | —           | 15.4          |                                                                           |
| 7                  | "          | 2,262         | —          | —           | 16.2          |                                                                           |
| 8                  | "          | 2,182         | —          | —           | 9.0           |                                                                           |
| 9                  | "          | —             | —          | —           | —             | Broke up at muzzle.                                                       |
| 10                 | "          | 2,261         | —          | —           | 13.0          |                                                                           |
| 11                 | "          | —             | —          | —           | —             | Broke up at muzzle.                                                       |
| 12                 | "          | 2,298         | —          | —           | 15.0          |                                                                           |
| 13                 | "          | 2,293         | —          | —           | 12.2          |                                                                           |
| 14                 | "          | 2,216         | —          | —           | 11.0          |                                                                           |
| 15                 | "          | 2,277         | —          | —           | 12.8          |                                                                           |
| 16                 | "          | 2,250         | —          | —           | 9.2           |                                                                           |
| 17                 | "          | 2,348         | —          | —           | 17.2          |                                                                           |
| 18                 | "          | 2,251         | —          | —           | 13.0          |                                                                           |
| 19                 | "          | 2,254         | —          | —           | 17.6          |                                                                           |
| 20                 | "          | 2,259         | —          | —           | 8.6           |                                                                           |
| 21                 | "          | 2,258         | —          | —           | 12.0          |                                                                           |
| 22                 | "          | 2,265         | —          | —           | 20.4          | Thomas Wilson.                                                            |

## SHRAPNEL SHELL—continued.

| No. of Round. | Elevation.   | Range.  | 1st Graze. |        |        | Remarks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       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|               |              |         | In Line.   | Right. | Left.  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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|               | °            | Yards.  |            | Yards. | Yards. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |  |       |    |         |       |    |        |
| 1             | 7            | 2,789   | —          | 2.0    | —      | <i>February 23, 1865.</i><br>This gun was 15 feet left of line.<br><br>Weather :—Very thick haze on water, 10 a.m.<br>Hazy, 3 p.m.<br>Wind :—Direction, W. by N. ; force, 3 ; 10 a.m.<br>" N.W. by W. ; " 3 ; 3 p.m.<br>Thermometer :—42 dry, 41 wet, 10 a.m.<br>47 " 46 " 3 p.m.<br>Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>30.30</td><td>41</td><td>10 a.m.</td></tr><tr><td>30.30</td><td>46</td><td>3 p.m.</td></tr></table><br>Broke up in the gun.<br>Broke up in the gun.<br><br>Broke up in the gun.<br><br>Broke up in the gun.<br><br>Broke up in the gun.<br><br>Broke up in the gun.<br><br>Broke up in the gun.<br><br>Broke up in the gun.<br><br>Broke up in the gun.<br><br>Broke up in the gun.<br><br>Broke up in the gun.<br><br>Broke up in the gun.<br><br>Broke up in the gun.<br><br>Broke up in the gun.<br><br>Broke up in the gun.<br><br>Broke up in the gun.<br><br>Broke up in the 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| Reading.      | Temperature. |         |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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| 30.30         | 41           | 10 a.m. |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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| 30.30         | 46           | 3 p.m.  |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |  |       |    |         |       |    |        |



# TARGET PRACTICE.

## SOLID SHOT.

*April 5, 1864.*

The firing was carried on against wooden targets divided into squares of 12 inches, inscribed circle in centre square being the bull's-eye.

RANGE, 200 yards. Five trial shots. Elevation, 2". Deflection, nil.

No. 1. 3.5 inches from centre.

|          |   |   |
|----------|---|---|
| " 2. 7   | " | " |
| " 3. 6   | " | " |
| " 4. 6   | " | " |
| " 5. 6.5 | " | " |

*April 6, 1864—continued.*

RANGE, 600 yards. Two trial shots. Elevation, 48'. Deflection, 4' left.

No. 1. 37.75 inches from centre.

|            |   |   |
|------------|---|---|
| " 2. 35.5  | " | " |
| " 3. 31.75 | " | " |
| " 4. 20    | " | " |
| " 5. 21.5  | " | " |

*April 7, 1864.*

RANGE, 300 yards. Five trial shots. Elevation, 13". Deflection, nil.

No. 1. 5.75 inches from centre.

|           |   |   |
|-----------|---|---|
| " 2. 0.75 | " | " |
| " 3. 5.5  | " | " |
| " 4. 6.5  | " | " |
| " 5. 5.0  | " | " |

RANGE, 800 yards. Three trial shots. Elevation, 1° 12'. Deflection, 5' left.

No. 1. 60.5 inches from centre.

|           |   |   |
|-----------|---|---|
| " 2. 29.5 | " | " |
| " 3. 39.5 | " | " |
| " 4. 21   | " | " |
| " 5. 24   | " | " |

RANGE, 400 yards. Five trial shots. Elevation, 24". Deflection, 2" left.

No. 1. 11.5 inches from centre.

|            |   |   |
|------------|---|---|
| " 2. 21.75 | " | " |
| " 3. 25.0  | " | " |
| " 4. 16.75 | " | " |
| " 5. 10.5  | " | " |

RANGE, 900 yards. Elevation, 1° 27'. Deflection, 5' left. Five trial shots.

No. 1. 12.5 inches from centre.

|            |   |   |
|------------|---|---|
| " 2. 27.25 | " | " |
| " 3. 41    | " | " |
| " 4. 26    | " | " |
| " 5. miss. | " | " |

*April 6, 1864.*

RANGE, 500 yards. Three trial shots. Elevation, 38'. Deflection, 3' left.

No. 1. 27 inches from centre.

|           |   |   |
|-----------|---|---|
| " 2. 3.5  | " | " |
| " 3. 33.5 | " | " |
| " 4. 18   | " | " |
| " 5. 24   | " | " |

*April 8, 1864.*

RANGE, 1,300 yards. Five trial shots. Elevation, 2° 28½' (No. 1), 2° 27' (No. 2 and remainder). Deflection, 3' left.

No. 1. 14.0 inches from centre.

|                               |   |   |
|-------------------------------|---|---|
| " 2. miss.                    | " | " |
| " 3. 26.5 inches from centre. | " | " |
| " 4. miss.                    | " | " |
| " 5. miss.                    | " | " |

TARGET PRACTICE.—SOLID SHOT—continued.

April 29, 1864.

May 10 and 12, 1864.

RANGE, 1,700 yards. Three 9-foot targets. Five trial shots not recorded.

RANGE, 2,000 yards. Three 9-foot targets. Five trial shots not recorded.

| No. of Round. | Inches from Centre. | 1st Graze. |       |        |        |
|---------------|---------------------|------------|-------|--------|--------|
|               |                     | Right.     | Left. | Short. | Over.  |
|               |                     | Feet.      | Feet. | Yards. | Yards. |
| 1             | —                   | —          | 4     | 50     | —      |
| 2             | 18                  | —          | —     | —      | —      |
| 3             | —                   | —          | 1     | —      | 4      |
| 4             | —                   | —          | —     | 53     | —      |
| 5             | 79                  | —          | —     | —      | —      |
| 6             | —                   | 1          | —     | 55     | —      |
| 7             | 56                  | —          | —     | —      | —      |
| 8             | 8                   | —          | —     | —      | —      |
| 9             | 71½                 | —          | —     | —      | —      |
| 10            | —                   | —          | 4½    | —      | 9      |
| 11            | —                   | 4½         | —     | —      | 5      |
| 12            | —                   | —          | —     | 57     | —      |
| 13            | 22¾                 | —          | —     | —      | —      |
| 14            | —                   | 1          | —     | —      | 28     |
| 15            | 40½                 | —          | —     | —      | —      |
| 16            | —                   | —          | 3     | —      | 7      |
| 17            | —                   | —          | —     | —      | 8      |
| 18            | —                   | —          | 1     | —      | 2      |
| 19            | —                   | —          | 3     | 35     | —      |
| 20            | 93½                 | —          | —     | —      | —      |

| No. of Round. | Inches from Centre. | 1st Graze. |       |        |        |
|---------------|---------------------|------------|-------|--------|--------|
|               |                     | Right.     | Left. | Short. | Over.  |
|               |                     | Feet.      | Feet. | Yards. | Yards. |
| 1             | 59½                 | —          | —     | —      | —      |
| 2             | 109                 | —          | —     | —      | —      |
| 3             | —                   | —          | 3     | —      | 40     |
| 4             | —                   | —          | 4     | 18     | —      |
| 5             | —                   | —          | 1     | 55     | —      |
| 6             | —                   | —          | 2     | 19     | —      |
| 7             | 28½                 | —          | —     | —      | —      |
| 8             | 100½                | —          | —     | —      | —      |
| 9             | —                   | 6          | —     | 50     | —      |
| 10            | —                   | —          | 3     | —      | 50     |
| 11            | —                   | —          | 6     | —      | 140    |
| 12            | —                   | —          | 4½    | —      | 160    |
| 13            | —                   | 6          | —     | —      | 30     |
| 14            | 89½                 | —          | —     | —      | —      |
| 15            | —                   | 6          | —     | —      | 50     |
| 16            | —                   | 6          | —     | 20     | —      |
| 17            | —                   | 4          | —     | —      | 40     |
| 18            | —                   | —          | —     | —      | 50     |
| 19            | 111                 | —          | —     | —      | —      |
| 20            | 22½                 | —          | —     | —      | —      |

May 11 and 12, 1864.

RANGE, 3,000 yards. Three 9-foot targets. Five trial shots not recorded.

| No. of Rounds. | Inches from Centre. | 1st Graze. |       |        |        |
|----------------|---------------------|------------|-------|--------|--------|
|                |                     | Right.     | Left. | Short. | Over.  |
|                |                     | Feet.      | Feet. | Yards. | Yards. |
| 1              | —                   | 5          | —     | —      | 21     |
| 2              | —                   | 15         | —     | —      | 15     |
| 3              | —                   | 11         | —     | —      | 24     |
| 4              | —                   | —          | —     | —      | 44     |
| 5              | —                   | —          | —     | 20     | —      |
| 6              | 56½                 | —          | —     | —      | —      |
| 7              | 105                 | —          | —     | —      | —      |
| 8              | —                   | 7          | —     | 16     | —      |
| 9              | —                   | —          | 15    | 34     | —      |
| 10             | —                   | 5          | —     | —      | 20     |
| 11             | —                   | 8          | —     | —      | 50     |
| 12             | —                   | —          | —     | —      | 60     |
| 13             | —                   | —          | 3     | —      | 64     |
| 14             | —                   | 9          | —     | —      | 56     |
| 15             | —                   | —          | 6     | —      | 45     |
| 16             | —                   | 5          | —     | —      | 50     |
| 17             | 115                 | —          | —     | —      | —      |
| 18             | 43½                 | —          | —     | —      | —      |
| 19             | —                   | 13         | —     | —      | 45     |
| 20             | —                   | —          | —     | 12     | —      |



TARGET PRACTICE—*continued.*

## BOXER'S SHRAPNEL SHELL (BLIND).

*April 28 and 29, 1864.**May 18, 1864.*

RANGE, 1,500 yards. Three 9-foot targets. Five trial shots not recorded.

RANGE, 2,600 yards. Three 9-foot targets. Five trial shots not recorded.

| No. of Round. | Inches from Centre. | 1st Graze.      |        |        |        | No. of Round. | Inches from Centre. | 1st Graze. |       |        |        |
|---------------|---------------------|-----------------|--------|--------|--------|---------------|---------------------|------------|-------|--------|--------|
|               |                     | Right.          | Left.  | Short. | Over.  |               |                     | Right.     | Left. | Short. | Over.  |
|               |                     | Yards.          | Yards. | Yards. | Yards. |               |                     | Feet.      | Feet. | Yards. | Yards. |
| 1             | 71 $\frac{1}{2}$    | —               | —      | —      | —      | 1             | —                   | 15         | —     | 50*    | —      |
| 2             | 64                  | —               | —      | —      | —      | 2             | —                   | —          | 14    | —      | 20     |
| 3             | 51 $\frac{1}{4}$    | —               | —      | —      | —      | 3             | —                   | 6          | —     | 1*     | —      |
| 4             | 76 $\frac{1}{2}$    | —               | —      | —      | —      | 4             | —                   | —          | 3     | 20*    | —      |
| 5             | —                   | —               | —      | —      | 56     | 5             | —                   | 30         | —     | 25*    | —      |
| 6             | 56 $\frac{1}{2}$    | —               | —      | —      | —      | 6             | —                   | —          | —     | —      | 25*    |
| 7             | —                   | —               | —      | 30     | —      | 7             | —                   | —          | 12    | —      | 50     |
| 8             | —                   | —               | —      | 50     | —      | 8             | —                   | —          | 4     | —      | 56     |
| 9             | 42 $\frac{1}{2}$    | —               | —      | —      | —      | 9             | —                   | 2          | —     | —      | 57     |
| 10            | 59 $\frac{1}{4}$    | —               | —      | —      | —      | 10            | —                   | —          | —     | 30*    | —      |
| 11            | —                   | 2 $\frac{1}{3}$ | —      | 4      | —      | 11            | —                   | 3          | —     | 42*    | —      |
| 12            | 46                  | —               | —      | —      | —      | 12            | —                   | —          | —     | 20*    | —      |
| 13            | 48 $\frac{1}{2}$    | —               | —      | —      | —      | 13            | —                   | —          | —     | 12*    | —      |
| 14            | —                   | —               | —      | —      | 47     | 14            | —                   | 3          | —     | —      | 25*    |
| 15            | —                   | —               | —      | 17     | —      | 15            | —                   | —          | 5     | 10     | —      |
| 16            | —                   | —               | —      | 30     | —      | 16            | —                   | 10         | —     | 24     | —      |
| 17            | —                   | $\frac{2}{3}$   | —      | 22     | —      | 17            | —                   | 9          | —     | —      | 23     |
| 18            | 18                  | —               | —      | —      | —      | 18            | —                   | —          | —     | —      | 35*    |
| 19            | 25 $\frac{1}{4}$    | —               | —      | —      | —      | 19            | —                   | 9          | —     | 2      | —      |
| 20            | 55 $\frac{1}{4}$    | —               | —      | —      | —      | 20            | —                   | —          | 12    | —      | 23     |

\* Broke up.

*May 19, 1864.*

RANGE, 3,000 yards. Three 9-foot targets. Five trial shots not recorded.

| No. of Round. | Inches from Centre. | 1st Graze. |       |        |        |
|---------------|---------------------|------------|-------|--------|--------|
|               |                     | Right.     | Left. | Short. | Over.  |
|               |                     | Feet.      | Feet. | Yards. | Yards. |
| 1             | 50                  | —          | —     | —      | —      |
| 2             | —                   | 20         | —     | —      | 30     |
| 3             | —                   | —          | 6     | —      | 80     |
| 4             | 44 $\frac{1}{2}$    | —          | —     | —      | —      |
| 5             | —                   | 6          | —     | 50     | —      |
| 6             | —                   | 6          | —     | —      | 20     |
| 7             | —                   | 15         | —     | —      | 8      |
| 8             | —                   | 20         | —     | 50     | —      |
| 9             | —                   | 6          | —     | —      | 60     |
| 10            | —                   | 10         | —     | 30     | —      |
| 11            | —                   | —          | —     | —      | 30     |
| 12            | —                   | 2          | —     | 30     | —      |
| 13            | —                   | —          | 6     | 25     | —      |
| 14            | —                   | 3          | —     | —      | 55     |
| 15            | 50 $\frac{1}{4}$    | —          | —     | —      | —      |
| 16            | —                   | 16         | —     | —      | 23     |
| 17            | —                   | 2          | —     | —      | 55     |
| 18            | —                   | 5          | —     | —      | 47     |
| 19            | —                   | 3          | —     | —      | 23     |
| 20            | —                   | 7          | —     | —      | 25     |

TARGET PRACTICE—*continued.*

## COMMON SHELL (BLIND).

*April 6, 1864.*

RANGE, 700 yards. One 9 ft. target. Two trial shots. Elevation,  $1^{\circ} 10'$ . Deflection,  $3'$  left.

No. 1. 31.25 inches from centre.

„ 2. 37.75 „ „

„ 3. 15 „ „

„ 4. miss. 76 in.

„ 5. miss. 76 in.

*April 28, 1864.*

RANGE, 1,200 yards. Three 9-foot targets. Five trial shots not recorded.

| No. of Round. | Inches from Centre. | 1st Graze. |       |        |        |
|---------------|---------------------|------------|-------|--------|--------|
|               |                     | Right.     | Left. | Short. | Over.  |
| 1             | 68                  | Feet.      | Feet. | Yards. | Yards. |
| 2             | $21\frac{3}{4}$     | —          | —     | —      | —      |
| 3             | —                   | —          | —     | 2      | —      |
| 4             | —                   | —          | —     | 25     | —      |
| 5             | $41\frac{1}{2}$     | —          | —     | —      | —      |
| 6             | —                   | —          | —     | 4      | —      |
| 7             | —                   | —          | —     | —      | 90     |
| 8             | —                   | —          | —     | —      | 86     |
| 9             | —                   | —          | —     | 28     | —      |
| 10            | $34\frac{1}{2}$     | —          | —     | —      | —      |
| 11            | 30                  | —          | —     | —      | —      |
| 12            | —                   | —          | —     | 29     | —      |
| 13            | —                   | —          | —     | —      | 70     |
| 14            | —                   | —          | —     | 6      | —      |
| 15            | 19                  | —          | —     | —      | —      |
| 16            | —                   | —          | —     | —      | 80     |
| 17            | —                   | —          | —     | —      | 70     |
| 18            | 42                  | —          | —     | —      | —      |
| 19            | —                   | —          | —     | 7      | —      |
| 20            | 56                  | —          | —     | —      | —      |



## EXPERIMENTS AGAINST EARTHWORKS AND ABBATIS.

April 8, 1864.

The following practice was carried on against an earthwork with the embrasure revetted with Jones' gabions. The work armed with cast-iron guns on garrison carriages, wood figures of men round each gun, and two 9-foot targets 6 feet in rear of each gun.

RANGE, 1,300 yards.

The firing to be carried on against the embrasures.

| No. | Elevation. | Deflection. | Projectile.   | Fuze.<br>Boxer's Time. |
|-----|------------|-------------|---------------|------------------------|
|     | ° /        | /           |               | /                      |
| 1   | 2 44       | 16 left     | Solid shot.   | —                      |
| 2   | "          | 17 "        | "             | —                      |
| 3   | "          | 17 "        | "             | —                      |
| 4   | "          | 17 "        | "             | —                      |
| 5   | "          | 18 "        | "             | —                      |
| 6   | 2 43       | 19 "        | Shrap. shell. | 2·05                   |
| 7   | "          | 19 "        | "             | 2·05                   |
| 8   | "          | 19 "        | "             | 2·                     |
| 9   | 2 44       | 20 "        | "             | 2·05                   |
| 10  | "          | 20 "        | "             | 2·05                   |

On target, 17 hits ; 1 through ; none of figures struck.

RANGE, 900 yards.

| No. | Elevation. | Deflection. | Projectile.  | Fuze.       |
|-----|------------|-------------|--------------|-------------|
|     | ° /        | /           |              | /           |
| 1   | 1 28       | 5 left      | Solid shot.  | —           |
| 2   | 1 30       | 5 "         | "            | —           |
| 3   | 1 32       | 5 "         | "            | —           |
| 4   | 1 33       | 5 "         | "            | —           |
| 5   | 1 36       | 5 "         | "            | —           |
| 6   | 1 38       | 5 "         | Shrap. shell | 2·25        |
| 7   | 1 39       | 5 "         | "            | "           |
| 8   | "          | 5 "         | "            | "           |
| 9   | "          | 5 "         | "            | "           |
| 10  | "          | 5 "         | "            | "           |
| 11  | 1 45       | 5 "         | Com. shell   | Concussion. |
| 12  | "          | 5 "         | "            | "           |
| 13  | "          | 8 "         | "            | "           |
| 14  | "          | 5 "         | "            | "           |
| 15  | "          | 5 "         | "            | "           |
| 16  | 1 44       | 5 "         | "            | "           |
| 17  | "          | 6 "         | "            | "           |
| 18  | "          | 6 "         | "            | "           |
| 19  | "          | 6 "         | "            | "           |
| 20  | "          | 6 "         | "            | "           |

The common shell practice was to damage the merlon. The shot and shrapnel shell against the embrasure.

The general results are as follows :—

On target, 58 through ; 6 lodged ; 6 struck ; 3 figures struck. Gun struck twice.

April 11, 1864.

RANGE, 700 yards, at embrasure only.

| No. | Elevation. | Deflection. | Projectile.  | Fuze.               |
|-----|------------|-------------|--------------|---------------------|
|     | ° /        | /           |              |                     |
| 1   | 58         | 4 left      | Shot.        | —                   |
| 2   | 1 2        | 3 "         | "            | —                   |
| 3   | 1 5        | 5 "         | "            | —                   |
| 4   | 1 4        | 5 "         | "            | —                   |
| 5   | "          | 5 "         | "            | —                   |
| 6   | "          | 5 "         | Shrap. shell | Boxer's concussion. |
| 7   | "          | 5 "         | "            | "                   |
| 8   | "          | 5 "         | "            | "                   |
| 9   | "          | 5 "         | "            | "                   |
| 10  | "          | 5 "         | "            | "                   |
| 11  | 1 7        | 5 "         | Com. shell   | "                   |
| 12  | 1 5        | 5 "         | "            | "                   |
| 13  | "          | 5 "         | "            | "                   |
| 14  | "          | 5 "         | "            | "                   |
| 15  | "          | 5 "         | "            | "                   |

The general results are as follows :—

On target, 28 through ; 6 lodged ; 6 struck ; 5 men hit.

## ABBATIS.

RANGE, 600 yards.

5 solid shot  
5 shrapnel shell  
5 common shell

} fired.

Concussion fuzes used.

The abbatiss was *very* little damaged, not sufficiently to admit of men passing through it.

## STOCKADES.

*Shoeburyness, April 18, 1864.*

The stockade, 18 feet long, 8 feet high, consisted of rough elm timbers, freshly felled, 12 feet long and 14 inches in thickness; the ends were sunk four feet in the ground, and the stockade strengthened by a strong oak brace in rear.

RANGE, 800 yards.

Targets 6 feet in rear to show the effect of the shell.

10 shrapnel shell,  
10 common shell,

were fired. The stockade, although but little damaged, owing to the wood being green, afforded no protection whatever, the targets in rear being broken to pieces.

As regards destructive effect there was no choice between the guns.

## WALLS.

The wall, 18 feet long, 8 feet high, 28 inches in thickness, was built of the best stock bricks and cement.

RANGE, 1,150 yards.

Targets 6 feet in rear to show the effect of the shell.

5 rounds solid shot.  
5 " shrapnel shell.  
5 " common shell,

were fired. At the conclusion of the practice there appeared to be very little difference in the amount of damage done by the guns.

That fired at by—

B.L. Armstrong was most damaged.  
M.L. Armstrong " next.  
Whitworth " next.

As regards the targets in rear, the relative damage done by the splinters of shells was as follows:—

M.L. Armstrong, most damage, most distributed.  
B.L. " next " most concentrated.  
Whitworth least damage, considerably less so than either of the other two.

RANGE, 1,000 yards.

PRACTICE with S. SHELL against FIELD ARTILLERY.

To burst 25 yards in front of gun.

- No. 1. Grazed 15 yards in front of the screen; balls, fragments, &c. intercepted by screen; 12 drs. burster used throughout.
2. Hit screen 5 feet from ground; 3 of gun detachment struck; 4 hits on gun carriage; 1 hit on limber.
3. Passed through the screen 4 feet from the ground; 4 of gun detachment struck; 1 hit on carriage.
4. Hit screen 6ft. 8in. from the ground; 7 of the gun detachment struck; 3 hits on gun carriage; 1 hit on limber.

The screens were then removed and the firing carried on at the guns.

5. Grazed 12 yards in front and burst on second graze behind the gun; damage done, nil.
6. Grazed 60 yards short, and burst on second graze behind the limber; damage done, nil.
7. Grazed 12 yards in front of the gun; 3 of gun detachment struck; 4 hits on gun carriage; 1 hit on the limber.
8. Grazed 17 yards in front and burst; 1 of the gun detachment hit; 6 hits on gun carriage.
9. Grazed 21 yards in front and burst; 4 men of the gun detachment hit; 2 hits on the carriage; 7 hits on the limber.

The 6-pounder guns and carriages at which the practice was carried on were "in action," limbers in rear, dummy figures placed to represent the gun detachment.

## ROPE MANTLETS.

## EFFECT AGAINST ROPE MANTLETS.

*June 3, 1864.*

SHRAPNEL SHELL.

RANGE, 400 yards.

The mantlets consisted of four plies of 4-inch rope frapped together with spun yarn in the usual manner.

A screen 3 inches thick was placed 23 yards in front of the mantlet, to burst the three first rounds of shell.

Two 9-foot targets, 6 yards in rear of mantlet.

No. 1. Burst 13 yards in front of the mantlet.  
8 hits on mantlet.  
6 through the mantlet.  
10 hits on target.

No. 2. Burst 13 yards in front of mantlet.  
9 hits on mantlet.  
4 through the mantlet.  
17 hits on target.

No. 3. Burst 18 yards in front of mantlet.  
7 hits on mantlet.  
4 through the mantlet.  
10 hits on the target.

No. 4. Burst on passing through mantlet, the screen having been removed.  
114 hits on the target.

No. 5. Burst on passing through the mantlet.  
102 hits on the target.



# DESTRUCTIVE EFFECT OF BOXER'S SHRAPNEL SHELL USED AS COMMON CASE.

May 5, 1864.

RANGE, 450 yards.

The target consisted of six lines of 2-inch deal boards 9 × 54 feet front, five yards interval. Five rounds shrapnel shell were fired.

| Line of Targets. | No. of Target. | Through. | Struck. |
|------------------|----------------|----------|---------|
| 1st Line -       | 1 right        | 9        | 3       |
|                  | 2              | 16       | 4       |
|                  | 3              | 21       | 1       |
|                  | 4              | 20       | 1       |
|                  | 5              | 3        | 0       |
|                  | 6              | 1        | 0       |
| 2nd Line -       | 1 right        | 3        | 1       |
|                  | 2              | 9        | 4       |
|                  | 3              | 77       | 4       |
|                  | 4              | 15       | 6       |
|                  | 5              | 6        | 0       |
|                  | 6              | 0        | 1       |
| 3rd Line -       | 1              | 3        | 1       |
|                  | 2              | 4        | 4       |
|                  | 3              | 65       | 10      |
|                  | 4              | 10       | 6       |
|                  | 5              | 62       | 1       |
|                  | 6              | 0        | 0       |
| 4th Line -       | 1              | 1        | 3       |
|                  | 2              | 3        | 5       |
|                  | 3              | 36       | 6       |
|                  | 4              | 15       | 8       |
|                  | 5              | 64       | 11      |
|                  | 6              | 0        | 0       |
| 5th Line -       | 1              | 0        | 0       |
|                  | 2              | 0        | 1       |
|                  | 3              | 15       | 3       |
|                  | 4              | 9        | 8       |
|                  | 5              | 42       | 9       |
|                  | 6              | 0        | 1       |
| 6th Line -       | 1              | 0        | 0       |
|                  | 2              | 0        | 0       |
|                  | 3              | 1        | 8       |
|                  | 4              | 0        | 6       |
|                  | 5              | 12       | 15      |
|                  | 6              | 2        | 1       |

May 6, 1864.

RANGE, 450 yards.

Five rounds shrapnel shell against the same six lines of targets.

The record taken of the number of men that would have been struck had the lines of targets been replaced by men :—

|            |   |   |         |
|------------|---|---|---------|
| 1st line - | - | - | 12 men. |
| 2nd ,      | - | - | 11 "    |
| 3rd "      | - | - | 17 "    |
| 4th "      | - | - | 15 "    |
| 5th "      | - | - | 16 "    |
| 6th "      | - | - | 18 "    |

May 9, 1864.

RANGE, 300 yards.

At single line of targets to represent men, 72 feet face.

|          |   |   |    |
|----------|---|---|----|
| 2 rounds | - | - | 5  |
| 3 "      | - | - | 14 |

May 10, 1864.

RANGE, 200 yards.

Single line of targets, 72 feet face, to represent men.

|          |   |   |    |
|----------|---|---|----|
| 2 rounds | - | - | 16 |
| 3 "      | - | - | 15 |

RANGE, 100 yards.

At the same targets.

|          |   |   |    |
|----------|---|---|----|
| 2 rounds | - | - | 24 |
| 3 "      | - | - | 26 |

RANGE, 50 yards.

At same targets.

|          |   |   |    |
|----------|---|---|----|
| 2 rounds | - | - | 13 |
| 3 "      | - | - | 16 |

(WHITWORTH) COMMON CASE.

October 17, 1864.

SHOEBURYNESS.

The targets consisted of one line of 2-inch targets. Area of face 54 × 9 feet.

| RANGE, 350 yards. |          |         |         | RANGE, 250 yards. |          |         |         |
|-------------------|----------|---------|---------|-------------------|----------|---------|---------|
| —                 | Through. | Lodged. | Struck. | —                 | Through. | Lodged. | Struck. |
| 1st Round.        |          |         |         | 1st Round.        |          |         |         |
| 1 target - -      | 2        | 0       | 1       | 1 target - -      | 0        | 0       | 0       |
| 2 " - -           | 2        | 0       | 0       | 2 " - -           | 3        | 3       | 1       |
| 3 " - -           | 2        | 0       | 1       | 3 " - -           | 0        | 1       | 1       |
| 4 " - -           | 3        | 0       | 0       | 4 " - -           | 5        | 0       | 0       |
| 5 " - -           | 2        | 2       | 0       | 5 " - -           | 5        | 1       | 0       |
| 6 " - -           | 0        | 2       | 1       | 6 " - -           | 1        | 2       | 0       |
| 2nd Round.        |          |         |         | 2nd Round.        |          |         |         |
| 1 target - -      | 0        | 0       | 0       | 1 target - -      | 1        | 0       | 0       |
| 2 " - -           | 2        | 1       | 1       | 2 " - -           | 4        | 3       | 0       |
| 3 " - -           | 1        | 0       | 1       | 3 " - -           | 6        | 5       | 0       |
| 4 " - -           | 0        | 3       | 0       | 4 " - -           | 1        | 1       | 0       |
| 5 " - -           | 2        | 0       | 1       | 5 " - -           | 0        | 1       | 0       |
| 6 " - -           | 1        | 0       | 2       | 6 " - -           | 0        | 0       | 0       |
| 3rd Round.        |          |         |         | 3rd Round.        |          |         |         |
| 1 target - -      | 0        | 0       | 0       | 1 target - -      | 2        | 0       | 0       |
| 2 " - -           | 0        | 0       | 0       | 2 " - -           | 4        | 0       | 0       |
| 3 " - -           | 2        | 4       | 1       | 3 " - -           | 3        | 1       | 0       |
| 4 " - -           | 0        | 2       | 2       | 4 " - -           | 2        | 1       | 0       |
| 5 " - -           | 1        | 5       | 0       | 5 " - -           | 1        | 1       | 0       |
| 6 " - -           | 2        | 0       | 3       | 6 " - -           | 6        | 1       | 0       |
| 4th Round.        |          |         |         | 4th Round.        |          |         |         |
| 1 target - -      | 1        | 1       | 0       | 1 target - -      | 0        | 1       | 0       |
| 2 " - -           | 0        | 3       | 0       | 2 " - -           | 4        | 0       | 0       |
| 3 " - -           | 0        | 4       | 0       | 3 " - -           | 3        | 0       | 0       |
| 4 " - -           | 2        | 1       | 2       | 4 " - -           | 5        | 2       | 1       |
| 5 " - -           | 1        | 1       | 1       | 5 " - -           | 6        | 0       | 0       |
| 6 " - -           | 2        | 0       | 1       | 6 " - -           | 3        | 2       | 0       |
| 5th Round.        |          |         |         | 5th Round.        |          |         |         |
| 1 target - -      | 1        | 0       | 0       | 1 target - -      | 0        | 1       | 0       |
| 2 " - -           | 0        | 4       | 0       | 2 " - -           | 6        | 3       | 0       |
| 3 " - -           | 1        | 0       | 0       | 3 " - -           | 5        | 1       | 0       |
| 4 " - -           | 1        | 4       | 1       | 4 " - -           | 8        | 1       | 0       |
| 5 " - -           | 2        | 4       | 0       | 5 " - -           | 7        | 0       | 0       |
| 6 " - -           | 0        | 0       | 0       | 6 " - -           | 1        | 0       | 0       |



## (WHITWORTH) COMMON CASE—continued.

RANGE, 200 yards.

RANGE, 150 yards.

|              | Through. | Lodged. | Struck. |              | Through. | Lodged. | Struck. |
|--------------|----------|---------|---------|--------------|----------|---------|---------|
| 1st Round.   |          |         |         | 1st Round.   |          |         |         |
| 1 target - - | 2        | 1       | 0       | 1 target - - | 2        | 0       | 0       |
| 2 " - -      | 5        | 2       | 2       | 2 " - -      | 0        | 0       | 0       |
| 3 " - -      | 0        | 0       | 0       | 3 " - -      | 4        | 2       | 1       |
| 4 " - -      | 15       | 1       | 0       | 4 " - -      | 5        | 0       | 0       |
| 5 " - -      | 7        | 0       | 0       | 5 " - -      | 4        | 0       | 0       |
| 6 " - -      | 0        | 1       | 0       | 6 " - -      | 7        | 0       | 1       |
| 2nd Round.   |          |         |         | 2nd Round.   |          |         |         |
| 1 target - - | 2        | 0       | 0       | 1 target - - | 0        | 0       | 2       |
| 2 " - -      | 4        | 1       | 0       | 2 " - -      | 7        | 1       | 0       |
| 3 " - -      | 12       | 1       | 0       | 3 " - -      | 26       | 0       | 0       |
| 4 " - -      | 8        | 2       | 0       | 4 " - -      | 15       | 1       | 1       |
| 5 " - -      | 2        | 0       | 1       | 5 " - -      | 6        | 2       | 0       |
| 6 " - -      | 2        | 0       | 0       | 6 " - -      | 0        | 0       | 0       |
| 3rd Round.   |          |         |         | 3rd Round.   |          |         |         |
| 1 target - - | 0        | 0       | 0       | 1 target - - | 0        | 1       | 0       |
| 2 " - -      | 4        | 1       | 1       | 2 " - -      | 2        | 0       | 0       |
| 3 " - -      | 13       | 2       | 0       | 3 " - -      | 14       | 1       | 0       |
| 4 " - -      | 9        | 0       | 0       | 4 " - -      | 10       | 0       | 2       |
| 5 " - -      | 3        | 0       | 0       | 5 " - -      | 3        | 0       | 0       |
| 6 " - -      | 4        | 0       | 0       | 6 " - -      | 1        | 0       | 0       |
| 4th Round.   |          |         |         | 4th Round.   |          |         |         |
| 1 target - - | 4        | 0       | 2       | 1 target - - | 1        | 0       | 1       |
| 2 " - -      | 3        | 1       | 2       | 2 " - -      | 4        | 0       | 1       |
| 3 " - -      | 10       | 0       | 0       | 3 " - -      | 3        | 0       | 2       |
| 4 " - -      | 10       | 1       | 0       | 4 " - -      | 4        | 1       | 0       |
| 5 " - -      | 5        | 0       | 0       | 5 " - -      | 2        | 2       | 1       |
| 6 " - -      | 1        | 1       | 0       | 6 " - -      | 3        | 3       | 4       |
| 5th Round.   |          |         |         | 5th Round.   |          |         |         |
| 1 target - - | 2        | 0       | 1       | 1 target - - | 0        | 3       | 0       |
| 2 " - -      | 7        | 0       | 2       | 2 " - -      | 1        | 0       | 2       |
| 3 " - -      | 11       | 0       | 1       | 3 " - -      | 5        | 0       | 1       |
| 4 " - -      | 0        | 2       | 2       | 4 " - -      | 13       | 0       | 0       |
| 5 " - -      | 4        | 1       | 1       | 5 " - -      | 7        | 1       | 0       |
| 6 " - -      | 2        | 0       | 0       | 6 " - -      | 0        | 0       | 0       |

RANGE, 50 yards.

|              | Through. | Lodged. | Struck. |              | Through. | Lodged. | Struck. |
|--------------|----------|---------|---------|--------------|----------|---------|---------|
| 1st Round.   |          |         |         | 4th Round.   |          |         |         |
| 1 target - - | 0        | 0       | 0       | 1 target - - | 3        | 1       | 0       |
| 2 " - -      | 0        | 0       | 0       | 2 " - -      | 72       | 6       | 0       |
| 3 " - -      | 7        | 1       | 0       | 3 " - -      | 6        | 3       | 3       |
| 4 " - -      | 86       | 6       | 0       | 4 " - -      | 0        | 1       | 1       |
| 5 " - -      | 7        | 0       | 0       | 5 " - -      | 1        | 0       | 1       |
| 6 " - -      | 1        | 0       | 0       | 6 " - -      | 0        | 0       | 0       |
| 2nd Round.   |          |         |         | 5th Round.   |          |         |         |
| 1 target - - | 1        | 2       | 0       | 1 target - - | 3        | 0       | 0       |
| 2 " - -      | 1        | 1       | 2       | 2 " - -      | 88       | 4       | 0       |
| 3 " - -      | 86       | 0       | 5       | 3 " - -      | 4        | 3       | 1       |
| 4 " - -      | 1        | 1       | 1       | 4 " - -      | 2        | 0       | 0       |
| 5 " - -      | 1        | 0       | 0       | 5 " - -      | 0        | 0       | 0       |
| 6 " - -      | 0        | 0       | 0       | 6 " - -      | 0        | 0       | 0       |
| 3rd Round.   |          |         |         |              |          |         |         |
| 1 target - - | 0        | 0       | 0       |              |          |         |         |
| 2 " - -      | 0        | 0       | 0       |              |          |         |         |
| 3 " - -      | 2        | 1       | 1       |              |          |         |         |
| 4 " - -      | 5        | 4       | 4       |              |          |         |         |
| 5 " - -      | 100      | 7       | 4       |              |          |         |         |
| 6 " - -      | 3        | 1       | 0       |              |          |         |         |

32 of these were large holes.

## DESTRUCTIVE EFFECT OF BOXER'S SHRAPNEL SHELL AGAINST TARGETS REPRESENTING TROOPS IN LINE AND IN COLUMN.

12 drs. burster, except at 100 yards, where 6 drs. were used, unless otherwise stated.

*May 30 and 31, 1864.*

RANGE, 600 yards.

The shells were fired at a screen 4 inches thick, placed in front of the targets, so as to insure the shells bursting 25 yards in front.

The targets consisted of three 9-foot targets 2 inches thick placed in line.

The shells struck the screen from 3 to 6 feet above the ground.

Boxer's concussion fuze.

| —                                       | —        | Through. | Lodged. | Struck. |
|-----------------------------------------|----------|----------|---------|---------|
| Struck 5 ft. 9 in.<br>above the ground. | 1 target | 11       | 1       | 0       |
|                                         | 2 "      | 42       | 3       | 2       |
|                                         | 3 "      | 4        | 0       | 2       |
| Struck 3 ft. 4 in.<br>above the ground. | 1 target | 15       | 1       | 0       |
|                                         | 2 "      | 11       | 3       | 0       |
|                                         | 3 "      | 14       | 3       | 0       |
| Struck 3 ft. 6 in.<br>above the ground. | 1 target | 7        | 2       | 4       |
|                                         | 2 "      | 9        | 2       | 0       |
|                                         | 3 "      | 8        | 0       | 0       |
| Struck 3 ft. 4 in.<br>above the ground. | 1 target | 14       | 0       | 0       |
|                                         | 2 "      | 9        | 1       | 0       |
|                                         | 3 "      | 14       | 1       | 0       |
| Struck 3 ft. 9 in.<br>above the ground. | 1 target | 11       | 0       | 0       |
|                                         | 2 "      | 9        | 0       | 0       |
|                                         | 3 "      | 14       | 1       | 0       |

The shells struck from the ground to 3 feet.

| —                                        | —        | Through. | Lodged. | Struck. |
|------------------------------------------|----------|----------|---------|---------|
| Struck 2 ft. 1 in.<br>above the ground.  | 1 target | 14       | 0       | 0       |
|                                          | 2 "      | 10       | 0       | 0       |
|                                          | 3 "      | 13       | 0       | 0       |
| Struck 22 inches<br>above the ground.    | 1 target | 13       | 2       | 0       |
|                                          | 2 "      | 4        | 1       | 0       |
|                                          | 3 "      | 9        | 0       | 0       |
| Struck 6 inches<br>above the ground.     | 1 target | 5        | 1       | 0       |
|                                          | 2 "      | 8        | 0       | 0       |
|                                          | 3 "      | 7        | 0       | 0       |
| Struck 1 ft. 10 in.<br>above the ground. | 1 target | 9        | 6       | 0       |
|                                          | 2 "      | 19       | 4       | 1       |
|                                          | 3 "      | 11       | 6       | 0       |
| Struck 2 ft. 11 in.<br>above the ground. | 1 target | 14       | 1       | 1       |
|                                          | 2 "      | 14       | 2       | 2       |
|                                          | 3 "      | 8        | 4       | 0       |

The screen was placed in front of the targets that the shells should burst 50 yards in front.

The shells struck from 4 to 7 feet from the ground.

| —                                       | —        | Through. | Lodged. | Struck. |
|-----------------------------------------|----------|----------|---------|---------|
| Struck 4 ft. 6 in.<br>above the ground. | 1 target | 6        | 1       | 0       |
|                                         | 2 "      | 8        | 0       | 0       |
|                                         | 3 "      | 8        | 0       | 0       |
| Struck 4 ft. 6 in.<br>above the ground. | 1 target | 3        | 0       | 0       |
|                                         | 2 "      | 8        | 0       | 0       |
|                                         | 3 "      | 1        | 0       | 0       |
| Struck 4 ft. 2 in.<br>above the ground. | 1 target | 0        | 1       | 0       |
|                                         | 2 "      | 4        | 0       | 2       |
|                                         | 3 "      | 3        | 0       | 0       |
|                                         | 4 "      | 1        | 0       | 1       |
|                                         | 5 "      | 7        | 0       | 0       |
|                                         | 6 "      | 3        | 0       | 1       |
| Struck 5 ft. 8 in.<br>above the ground. | 1 target | 5        | 1       | 0       |
|                                         | 2 "      | 5        | 0       | 0       |
|                                         | 3 "      | 1        | 0       | 2       |
|                                         | 4 "      | 4        | 2       | 0       |
|                                         | 5 "      | 8        | 2       | 0       |
|                                         | 6 "      | 1        | 0       | 0       |
| Struck 6 ft. above<br>the ground.       | 1 target | 1        | 0       | 0       |
|                                         | 2 "      | 6        | 0       | 0       |
|                                         | 3 "      | 4        | 1       | 0       |
|                                         | 4 "      | 4        | 0       | 0       |
|                                         | 5 "      | 6        | 0       | 2       |
|                                         | 6 "      | 3        | 0       | 1       |

The shells struck from the ground to 4 feet above.

| —                                       | —        | Through. | Lodged. | Struck. |
|-----------------------------------------|----------|----------|---------|---------|
| Struck 3 ft. 2 in.<br>above the ground. | 1 target | 5        | 0       | 2       |
|                                         | 2 "      | 5        | 2       | 0       |
|                                         | 3 "      | 3        | 0       | 2       |
| Struck 12 in. above<br>the ground.      | 1 target | 7        | 0       | 0       |
|                                         | 2 "      | 8        | 0       | 0       |
|                                         | 3 "      | 10       | 0       | 2       |
| Struck 3 ft. above<br>the ground.       | 1 target | 14       | 2       | 1       |
|                                         | 2 "      | 14       | 1       | 1       |
|                                         | 3 "      | 13       | 0       | 0       |
| Struck 2 ft. 9 in.<br>above the ground. | 1 target | 6        | 1       | 0       |
|                                         | 2 "      | 8        | 0       | 0       |
|                                         | 3 "      | 4        | 0       | 0       |
| Struck 3 ft. 9 in.<br>above the ground. | 1 target | 0        | 0       | 0       |
|                                         | 2 "      | 7        | 1       | 0       |
|                                         | 3 "      | 7        | 1       | 0       |
|                                         | 4 "      | 2        | 1       | 0       |
|                                         | 5 "      | 8        | 0       | 0       |
|                                         | 6 "      | 3        | 1       | 0       |



BOXER'S SHRAPNEL SHELL—*continued.*

June 1, 1864.

RANGE, 600 yards.

The shells fired at a screen placed so as to burst them 100 yards in front of targets.

The shells struck the screen from 10 to 7 feet from the ground.

The shells struck the screen from 7 feet to ground.

| —                                       | —        | Through. | Lodged. | Struck. | —                                       | —        | Through. | Lodged. | Struck. |
|-----------------------------------------|----------|----------|---------|---------|-----------------------------------------|----------|----------|---------|---------|
| Struck 7 ft. 8 in.<br>above ground.     | 1 target | 3        | 1       | 0       | Struck 6 ft. 4 in.<br>above the ground. | 1 target | 2        | 0       | 1       |
|                                         | 2 "      | 1        | 0       | 1       |                                         | 2 "      | 1        | 0       | 1       |
|                                         | 3 "      | 1        | 0       | 1       |                                         | 3 "      | 2        | 0       | 0       |
|                                         | 4 "      | 1        | 1       | 1       |                                         | 4 "      | 1        | 0       | 0       |
|                                         | 5 "      | 2        | 1       | 0       |                                         | 5 "      | 0        | 0       | 1       |
|                                         | 6 "      | 0        | 0       | 0       |                                         | 6 "      | 1        | 0       | 1       |
|                                         | 7 "      | 1        | 0       | 1       |                                         | 7 "      | 1        | 0       | 1       |
|                                         | 8 "      | 2        | 0       | 1       |                                         | 8 "      | 0        | 3       | 0       |
| Struck 8 ft. 9 in.<br>above ground.     | 1 target | 1        | 1       | 0       | Struck 6 ft. 2 in.<br>above the ground. | 1 target | 4        | 0       | 0       |
|                                         | 2 "      | 0        | 0       | 2       |                                         | 2 "      | 2        | 1       | 0       |
|                                         | 3 "      | 1        | 0       | 0       |                                         | 3 "      | 2        | 1       | 0       |
|                                         | 4 "      | 1        | 0       | 3       |                                         | 4 "      | 1        | 0       | 0       |
|                                         | 5 "      | 1        | 0       | 2       |                                         | 5 "      | 2        | 0       | 2       |
|                                         | 6 "      | 0        | 0       | 1       |                                         | 6 "      | 0        | 0       | 2       |
|                                         | 7 "      | 0        | 0       | 1       |                                         | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 1        | 0       | 2       |                                         | 8 "      | 1        | 0       | 0       |
| Struck 8 ft. 2 in.<br>above the ground. | 1 target | 0        | 0       | 1       | Struck 3 ft. 3 in.<br>above the ground. | 1 target | 2        | 0       | 0       |
|                                         | 2 "      | 2        | 0       | 0       |                                         | 2 "      | 0        | 1       | 0       |
|                                         | 3 "      | 4        | 0       | 2       |                                         | 3 "      | 3        | 2       | 1       |
|                                         | 4 "      | 1        | 0       | 0       |                                         | 4 "      | 0        | 1       | 0       |
|                                         | 5 "      | 2        | 1       | 0       |                                         | 5 "      | 1        | 1       | 1       |
|                                         | 6 "      | 0        | 1       | 3       |                                         | 6 "      | 2        | 0       | 2       |
|                                         | 7 "      | 4        | 1       | 1       |                                         | 7 "      | 2        | 1       | 1       |
|                                         | 8 "      | 0        | 0       | 0       |                                         | 8 "      | 1        | 0       | 2       |
| Struck 9 ft. 1 in.<br>above the ground. | 1 target | 0        | 0       | 1       | Struck 6 ft. 3 in.<br>above the ground. | 1 target | 1        | 1       | 0       |
|                                         | 2 "      | 1        | 0       | 0       |                                         | 2 "      | 5        | 0       | 2       |
|                                         | 3 "      | 4        | 1       | 1       |                                         | 3 "      | 2        | 0       | 0       |
|                                         | 4 "      | 1        | 0       | 0       |                                         | 4 "      | 0        | 0       | 0       |
|                                         | 5 "      | 4        | 1       | 1       |                                         | 5 "      | 1        | 0       | 0       |
|                                         | 6 "      | 0        | 0       | 0       |                                         | 6 "      | 1        | 0       | 1       |
|                                         | 7 "      | 2        | 0       | 1       |                                         | 7 "      | 2        | 0       | 1       |
|                                         | 8 "      | 1        | 0       | 2       |                                         | 8 "      | 1        | 1       | 1       |
| Struck 7 ft. 7 in.<br>above the ground. | 1 target | 0        | 0       | 0       | Struck 4 ft. 4 in.<br>above the ground. | 1 target | 0        | 1       | 1       |
|                                         | 2 "      | 2        | 0       | 0       |                                         | 2 "      | 2        | 0       | 1       |
|                                         | 3 "      | 4        | 1       | 0       |                                         | 3 "      | 3        | 0       | 1       |
|                                         | 4 "      | 2        | 0       | 0       |                                         | 4 "      | 0        | 0       | 2       |
|                                         | 5 "      | 0        | 0       | 2       |                                         | 5 "      | 2        | 0       | 1       |
|                                         | 6 "      | 3        | 0       | 0       |                                         | 6 "      | 0        | 0       | 1       |
|                                         | 7 "      | 2        | 0       | 0       |                                         | 7 "      | 2        | 0       | 1       |
|                                         | 8 "      | 2        | 0       | 0       |                                         | 8 "      | 3        | 0       | 1       |

BOXER'S SHRAPNEL SHELL—*continued.*

June 9, 1864.

RANGE, 800 yards.

The screen was placed 20 yards in front of the target, so as to insure the shells bursting 10 yards in front of the target.

From the ground to 5 feet.

Struck the screen from 5 to 8½ feet.

| —                                                                         | —        | Through. | Lodged. | Struck. | —                                       | —        | Through. | Lodged. | Struck. |
|---------------------------------------------------------------------------|----------|----------|---------|---------|-----------------------------------------|----------|----------|---------|---------|
| Shell struck 1 ft.<br>6 in. above the<br>ground.                          | 1 target | 0        | 0       | 0       | Shell struck 6 ft.<br>above the ground. | 1 target | 1        | 0       | 0       |
|                                                                           | 2 "      | 1        | 0       | 0       |                                         | 2 "      | 0        | 0       | 0       |
|                                                                           | 3 "      | 2        | 0       | 0       |                                         | 3 "      | 0        | 0       | 0       |
|                                                                           | 4 "      | 37       | 0       | 0       | 12 drs. burster.                        | 4 "      | 23       | 4       | 1       |
| 12 drs. burster.                                                          | 5 "      | 21       | 1       | 2       |                                         | 5 "      | 27       | 0       | 0       |
|                                                                           | 6 "      | 3        | 0       | 1       |                                         | 6 "      | 2        | 0       | 0       |
|                                                                           | 7 "      | 0        | 1       | 0       |                                         | 7 "      | 0        | 0       | 0       |
|                                                                           | 8 "      | 0        | 0       | 0       |                                         | 8 "      | 0        | 0       | 0       |
| Shell struck 4 ft.<br>above the ground.                                   | 1 target | 0        | 0       | 0       | Struck 6 ft. 9 in.<br>above the ground. | 1 target | 0        | 0       | 0       |
|                                                                           | 2 "      | 0        | 0       | 0       |                                         | 2 "      | 0        | 0       | 0       |
|                                                                           | 3 "      | 2        | 1       | 0       |                                         | 3 "      | 0        | 0       | 1       |
| 12 drs. burster                                                           | 4 "      | 19       | 0       | 0       | 12 drs. burster.                        | 4 "      | 27       | 2       | 1       |
|                                                                           | 5 "      | 43       | 0       | 0       |                                         | 5 "      | 31       | 2       | 0       |
|                                                                           | 6 "      | 4        | 0       | 0       |                                         | 6 "      | 3        | 0       | 0       |
|                                                                           | 7 "      | 0        | 1       | 0       |                                         | 7 "      | 0        | 0       | 0       |
|                                                                           | 8 "      | 0        | 0       | 0       |                                         | 8 "      | 0        | 0       | 0       |
| One round missed target and screen, grazed on<br>sand, and did not burst. |          |          |         |         | Struck 7 ft. 9 in.<br>above the ground. | 1 target | 0        | 0       | 1       |
|                                                                           | 1 target | 0        | 0       | 0       |                                         | 2 "      | 0        | 0       | 0       |
| Shell struck 1 ft.<br>above the ground.                                   | 2 "      | 0        | 1       | 0       |                                         | 3 "      | 4        | 0       | 1       |
|                                                                           | 3 "      | 2        | 0       | 0       | 12 drs. burster.                        | 4 "      | 28       | 1       | 0       |
|                                                                           | 4 "      | 17       | 0       | 0       |                                         | 5 "      | 25       | 2       | 0       |
| 12 drs. burster.                                                          | 5 "      | 40       | 2       | 0       |                                         | 6 "      | 0        | 0       | 1       |
|                                                                           | 6 "      | 5        | 0       | 0       |                                         | 7 "      | 0        | 0       | 0       |
|                                                                           | 7 "      | 2        | 0       | 0       |                                         | 8 "      | 0        | 0       | 0       |
|                                                                           | 8 "      | 0        | 0       | 0       | Struck 5 ft. 6 in.<br>above the ground. | 1 target | 0        | 0       | 0       |
| Shell struck 6 in.<br>above the ground.                                   | 1 target | 0        | 0       | 0       |                                         | 2 "      | 0        | 0       | 0       |
|                                                                           | 2 "      | 0        | 0       | 0       |                                         | 3 "      | 0        | 0       | 0       |
|                                                                           | 3 "      | 2        | 0       | 0       | 12 drs. burster.                        | 4 "      | 26       | 2       | 0       |
| 12 drs. burster.                                                          | 4 "      | 22       | 1       | 1       |                                         | 5 "      | 29       | 4       | 0       |
|                                                                           | 5 "      | 27       | 1       | 2       |                                         | 6 "      | 2        | 1       | 0       |
|                                                                           | 6 "      | 2        | 1       | 1       |                                         | 7 "      | 0        | 0       | 0       |
|                                                                           | 7 "      | 0        | 0       | 0       |                                         | 8 "      | 0        | 0       | 0       |
|                                                                           | 8 "      | 0        | 0       | 0       | Struck 6 ft. 6 in.<br>above the ground. | 1 target | 0        | 0       | 0       |
| Shell struck 1 ft.<br>8 in. above the<br>ground.                          | 1 target | 0        | 0       | 0       |                                         | 2 "      | 0        | 0       | 0       |
|                                                                           | 2 "      | 1        | 0       | 0       |                                         | 3 "      | 5        | 0       | 0       |
|                                                                           | 3 "      | 5        | 0       | 1       | 12 drs. burster.                        | 4 "      | 25       | 2       | 1       |
|                                                                           | 4 "      | 39       | 2       | 1       |                                         | 5 "      | 21       | 1       | 1       |
| 12 drs. burster.                                                          | 5 "      | 28       | 2       | 0       |                                         | 6 "      | 3        | 0       | 0       |
|                                                                           | 6 "      | 1        | 1       | 0       |                                         | 7 "      | 0        | 0       | 0       |
|                                                                           | 7 "      | 0        | 0       | 0       |                                         | 8 "      | 0        | 0       | 0       |
|                                                                           | 8 "      | 0        | 0       | 0       |                                         |          |          |         |         |



BOXER'S SHRAPNEL SHELL—*continued.*

June 10, 1864.

RANGE, 800 yards.

The steel to burst 25 yards in front of the targets.

From 5 to 9 feet from ground.

Shell to strike from ground to 5 feet.

|                                         |          | Through. | Lodged. | Struck. |                                                   |          | Through. | Lodged. | Struck. |
|-----------------------------------------|----------|----------|---------|---------|---------------------------------------------------|----------|----------|---------|---------|
| Struck 7 ft. 4 in.<br>above the ground. | 1 target | 0        | 0       | 0       | Shell struck 1 ft.<br>10 in. above the<br>ground. | 1 target | 0        | 0       | 0       |
|                                         | 2 "      | 1        | 1       | 0       |                                                   | 2 "      | 0        | 0       | 0       |
|                                         | 3 "      | 2        | 0       | 0       |                                                   | 3 "      | 2        | 0       | 0       |
| 12 drs. burster.                        | 4 "      | 23       | 2       | 0       |                                                   | 4 "      | 14       | 0       | 0       |
|                                         | 5 "      | 20       | 1       | 0       | 12 drs. burster.                                  | 5 "      | 38       | 0       | 0       |
|                                         | 6 "      | 1        | 1       | 0       |                                                   | 6 "      | 2        | 0       | 0       |
|                                         | 7 "      | 2        | 0       | 0       |                                                   | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 0        | 0       | 0       |                                                   | 8 "      | 0        | 0       | 0       |
| Struck 7 ft. 4 in.<br>above the ground. | 1 target | 0        | 0       | 0       | Struck 3 ft. 7 in.<br>above the ground.           | 1 target | 0        | 0       | 0       |
|                                         | 2 "      | 0        | 0       | 0       |                                                   | 2 "      | 1        | 0       | 0       |
|                                         | 3 "      | 4        | 0       | 0       |                                                   | 3 "      | 2        | 0       | 0       |
| 12 drs. burster.                        | 4 "      | 20       | 0       | 0       | 12 drs. burster.                                  | 4 "      | 28       | 5       | 2       |
|                                         | 5 "      | 23       | 0       | 0       |                                                   | 5 "      | 17       | 3       | 0       |
|                                         | 6 "      | 3        | 3       | 0       |                                                   | 6 "      | 7        | 2       | 0       |
|                                         | 7 "      | 2        | 0       | 1       |                                                   | 7 "      | 1        | 0       | 0       |
|                                         | 8 "      | 1        | 0       | 0       |                                                   | 8 "      | 0        | 0       | 0       |
| Struck 7 ft. 6 in.<br>above the ground. | 1 target | 0        | 0       | 1       | Struck 2 ft. 4 in.<br>above the ground.           | 1 target | 1        | 0       | 0       |
|                                         | 2 "      | 2        | 0       | 0       |                                                   | 2 "      | 1        | 1       | 0       |
|                                         | 3 "      | 1        | 1       | 0       |                                                   | 3 "      | 4        | 0       | 0       |
| 12 drs. burster.                        | 4 "      | 17       | 4       | 2       | 12 drs. burster.                                  | 4 "      | 28       | 0       | 0       |
|                                         | 5 "      | 14       | 1       | 0       |                                                   | 5 "      | 22       | 1       | 2       |
|                                         | 6 "      | 5        | 2       | 0       |                                                   | 6 "      | 2        | 0       | 0       |
|                                         | 7 "      | 0        | 0       | 0       |                                                   | 7 "      | 2        | 0       | 0       |
|                                         | 8 "      | 0        | 0       | 0       |                                                   | 8 "      | 0        | 0       | 0       |
| Struck 5 ft. 2 in.<br>above the ground. | 1 target | 0        | 0       | 0       | Struck 1 ft. 2 in.<br>above the ground.           | 1 target | 0        | 0       | 0       |
|                                         | 2 "      | 2        | 0       | 0       |                                                   | 2 "      | 1        | 0       | 0       |
|                                         | 3 "      | 40       | 1       | 1       |                                                   | 3 "      | 1        | 0       | 0       |
| 12 drs. burster.                        | 4 "      | 16       | 0       | 0       | 12 drs. burster.                                  | 4 "      | 28       | 0       | 0       |
|                                         | 5 "      | 4        | 0       | 0       |                                                   | 5 "      | 22       | 1       | 0       |
|                                         | 6 "      | 0        | 0       | 0       |                                                   | 6 "      | 2        | 0       | 0       |
|                                         | 7 "      | 0        | 0       | 0       |                                                   | 7 "      | 0        | 0       | 0       |
|                                         | 8 "      | 0        | 0       | 0       |                                                   | 8 "      | 0        | 0       | 0       |
| Struck 6 ft. above<br>the ground.       | 1 target | 0        | 0       | 0       | Struck 2 ft. above<br>the ground.                 | 1 target | 2        | 0       | 0       |
|                                         | 2 "      | 2        | 0       | 0       |                                                   | 2 "      | 1        | 1       | 0       |
|                                         | 3 "      | 5        | 0       | 0       |                                                   | 3 "      | 11       | 0       | 0       |
| 12 drs. burster.                        | 4 "      | 26       | 0       | 0       | 12 drs. burster.                                  | 4 "      | 15       | 2       | 2       |
|                                         | 5 "      | 16       | 1       | 0       |                                                   | 5 "      | 24       | 4       | 0       |
|                                         | 6 "      | 3        | 0       | 0       |                                                   | 6 "      | 2        | 2       | 0       |
|                                         | 7 "      | 2        | 0       | 0       |                                                   | 7 "      | 2        | 1       | 1       |
|                                         | 8 "      | 0        | 0       | 0       |                                                   | 8 "      | 0        | 0       | 0       |

BOXER'S SHRAPNEL SHELL—continued.

June 13, 1864.

RANGE, 800 yards.

The shells were burst 50 yards in front of the targets.

The shell to strike the screen from 6 to 10 feet from the ground.

From the ground to 6 feet.

|                                                          |          | Through. | Lodged. | Struck. |                                                          |          | Through. | Lodged. | Struck. |
|----------------------------------------------------------|----------|----------|---------|---------|----------------------------------------------------------|----------|----------|---------|---------|
| Struck 8 ft. 8 in. above the ground.<br>12 drs. burster. | 1 target | 0        | 0       | 0       | Struck 5 ft. 6 in. above the ground.<br>12 drs. burster. | 1 target | 0        | 0       | 0       |
|                                                          | 2 "      | 0        | 0       | 0       |                                                          | 2 "      | 0        | 0       | 0       |
|                                                          | 3 "      | 9        | 1       | 0       |                                                          | 3 "      | 11       | 0       | 1       |
|                                                          | 4 "      | 6        | 1       | 1       |                                                          | 4 "      | 11       | 0       | 0       |
|                                                          | 5 "      | 7        | 0       | 1       |                                                          | 5 "      | 5        | 0       | 0       |
|                                                          | 6 "      | 8        | 0       | 0       |                                                          | 6 "      | 8        | 0       | 0       |
|                                                          | 7 "      | 1        | 0       | 0       |                                                          | 7 "      | 2        | 0       | 0       |
|                                                          | 8 "      | 1        | 0       | 1       |                                                          | 8 "      | 0        | 0       | 0       |
| Struck 8 ft. above the ground.<br>12 drs. burster.       | 1 target | 1        | 0       | 0       | Struck 2 ft. 6 in. above the ground.<br>12 drs. burster. | 1 target | 2        | 0       | 0       |
|                                                          | 2 "      | 1        | 0       | 0       |                                                          | 2 "      | 1        | 0       | 0       |
|                                                          | 3 "      | 7        | 0       | 0       |                                                          | 3 "      | 12       | 0       | 0       |
|                                                          | 4 "      | 7        | 1       | 0       |                                                          | 4 "      | 5        | 0       | 0       |
|                                                          | 5 "      | 6        | 0       | 2       |                                                          | 5 "      | 12       | 0       | 0       |
|                                                          | 6 "      | 6        | 2       | 0       |                                                          | 6 "      | 1        | 0       | 0       |
|                                                          | 7 "      | 4        | 0       | 0       |                                                          | 7 "      | 0        | 0       | 0       |
|                                                          | 8 "      | 0        | 0       | 0       |                                                          | 8 "      | 1        | 0       | 0       |
| Struck 7 ft. above the ground.<br>12 drs. burster.       | 1 target | 0        | 0       | 0       | Struck 3 ft. 9 in. above the ground.<br>12 drs. burster. | 1 target | 0        | 0       | 0       |
|                                                          | 2 "      | 2        | 0       | 0       |                                                          | 2 "      | 3        | 0       | 0       |
|                                                          | 3 "      | 6        | 1       | 0       |                                                          | 3 "      | 8        | 1       | 0       |
|                                                          | 4 "      | 7        | 0       | 0       |                                                          | 4 "      | 11       | 2       | 1       |
|                                                          | 5 "      | 10       | 2       | 0       |                                                          | 5 "      | 9        | 1       | 1       |
|                                                          | 6 "      | 8        | 0       | 0       |                                                          | 6 "      | 7        | 0       | 0       |
|                                                          | 7 "      | 3        | 0       | 0       |                                                          | 7 "      | 0        | 0       | 0       |
|                                                          | 8 "      | 0        | 0       | 0       |                                                          | 8 "      | 0        | 1       | 0       |
| Struck 10 ft. above the ground.<br>12 drs. burster.      | 1 target | 0        | 0       | 0       | Struck 5 ft. 2 in. above the ground.<br>12 drs. burster. | 1 target | 1        | 0       | 0       |
|                                                          | 2 "      | 0        | 0       | 0       |                                                          | 2 "      | 1        | 0       | 0       |
|                                                          | 3 "      | 10       | 0       | 1       |                                                          | 3 "      | 5        | 1       | 2       |
|                                                          | 4 "      | 15       | 3       | 0       |                                                          | 4 "      | 9        | 0       | 1       |
|                                                          | 5 "      | 9        | 1       | 0       |                                                          | 5 "      | 9        | 0       | 1       |
|                                                          | 6 "      | 5        | 0       | 0       |                                                          | 6 "      | 13       | 0       | 0       |
|                                                          | 7 "      | 1        | 0       | 0       |                                                          | 7 "      | 2        | 1       | 0       |
|                                                          | 8 "      | 2        | 0       | 0       |                                                          | 8 "      | 0        | 0       | 0       |
|                                                          |          |          |         |         | Struck 4 ft. 3 in. above the ground.<br>12 drs. burster. | 1 target | 0        | 0       | 0       |
|                                                          |          |          |         |         |                                                          | 2 "      | 0        | 0       | 0       |
|                                                          |          |          |         |         |                                                          | 3 "      | 2        | 0       | 0       |
|                                                          |          |          |         |         |                                                          | 4 "      | 7        | 0       | 0       |
|                                                          |          |          |         |         |                                                          | 5 "      | 8        | 0       | 0       |
|                                                          |          |          |         |         |                                                          | 6 "      | 5        | 0       | 0       |
|                                                          |          |          |         |         |                                                          | 7 "      | 0        | 0       | 0       |
|                                                          |          |          |         |         |                                                          | 8 "      | 0        | 0       | 0       |

Four rounds were only recorded at this height.



BOXER'S SHRAPNEL SHELL—*continued*

June 14, 1864.

RANGE, 800 yards.

The shell to burst 100 yards in front of the targets.

To strike the screen from 9 to 13 ft. from the ground.

The shell to strike the screen from 9 ft. to the ground.

| —                                      | —        | Through. | Lodged. | Struck. | —                                    | —        | Through. | Lodged. | Struck. |
|----------------------------------------|----------|----------|---------|---------|--------------------------------------|----------|----------|---------|---------|
| Struck 9 ft. above the ground.         | 1 target | 0        | 0       | 1       | Struck 6 ft. above the ground.       | 1 target | 1        | 0       | 0       |
|                                        | 2 "      | 7        | 0       | 1       |                                      | 2 "      | 4        | 0       | 0       |
|                                        | 3 "      | 1        | 1       | 0       |                                      | 3 "      | 7        | 1       | 0       |
| 6 drs. burster.                        | 4 "      | 6        | 1       | 1       | 6 drs. burster.                      | 4 "      | 10       | 0       | 0       |
|                                        | 5 "      | 0        | 0       | 1       |                                      | 5 "      | 11       | 1       | 0       |
|                                        | 6 "      | 3        | 0       | 0       |                                      | 6 "      | 4        | 0       | 0       |
|                                        | 7 "      | 2        | 0       | 0       |                                      | 7 "      | 0        | 0       | 0       |
|                                        | 8 "      | 0        | 0       | 0       |                                      | 8 "      | 0        | 0       | 0       |
| Struck 11 ft. 11 in. above the ground. | 1 target | 0        | 0       | 0       | Struck 2 ft. above the ground.       | 1 target | 0        | 0       | 0       |
|                                        | 2 "      | 4        | 0       | 0       |                                      | 2 "      | 2        | 0       | 0       |
|                                        | 3 "      | 2        | 0       | 0       |                                      | 3 "      | 11       | 1       | 0       |
| 6 drs. burster.                        | 4 "      | 1        | 1       | 0       | 6 drs. burster.                      | 4 "      | 4        | 1       | 0       |
|                                        | 5 "      | 3        | 0       | 0       |                                      | 5 "      | 7        | 0       | 0       |
|                                        | 6 "      | 6        | 0       | 0       |                                      | 6 "      | 11       | 0       | 0       |
|                                        | 7 "      | 1        | 2       | 0       |                                      | 7 "      | 8        | 2       | 0       |
|                                        | 8 "      | 0        | 0       | 0       |                                      | 8 "      | 3        | 0       | 0       |
| Struck 11 ft. 10 in. above the ground. | 1 target | 0        | 0       | 0       | Struck 2 ft. 4 in. above the ground. | 1 target | 0        | 0       | 0       |
|                                        | 2 "      | 3        | 0       | 0       |                                      | 2 "      | 6        | 0       | 0       |
|                                        | 3 "      | 3        | 0       | 0       |                                      | 3 "      | 5        | 1       | 0       |
| 6 drs. burster.                        | 4 "      | 3        | 0       | 0       | 6 drs. burster.                      | 4 "      | 5        | 0       | 0       |
|                                        | 5 "      | 2        | 1       | 0       |                                      | 5 "      | 4        | 0       | 0       |
|                                        | 6 "      | 4        | 0       | 0       |                                      | 6 "      | 5        | 1       | 0       |
|                                        | 7 "      | 1        | 0       | 0       |                                      | 7 "      | 6        | 0       | 0       |
|                                        | 8 "      | 0        | 2       | 0       |                                      | 8 "      | 2        | 0       | 0       |
| Struck 9 ft. above the ground.         | 1 target | 2        | 0       | 0       | Struck 3 ft. above the ground.       | 1 target | 0        | 1       | 0       |
|                                        | 2 "      | 2        | 1       | 0       |                                      | 2 "      | 7        | 0       | 0       |
|                                        | 3 "      | 2        | 0       | 0       |                                      | 3 "      | 1        | 0       | 0       |
| 6 drs. burster.                        | 4 "      | 3        | 0       | 0       | 6 drs. burster.                      | 4 "      | 2        | 0       | 0       |
|                                        | 5 "      | 1        | 0       | 0       |                                      | 5 "      | 3        | 0       | 0       |
|                                        | 6 "      | 2        | 0       | 0       |                                      | 6 "      | 3        | 0       | 0       |
|                                        | 7 "      | 1        | 2       | 0       |                                      | 7 "      | 0        | 1       | 0       |
|                                        | 8 "      | 0        | 0       | 0       |                                      | 8 "      | 0        | 0       | 0       |
| Struck 9 ft. above the ground.         | 1 target | 0        | 1       | 0       | Struck 3 ft. 7 in. above the ground. | 1 target | 0        | 2       | 0       |
|                                        | 2 "      | 1        | 1       | 1       |                                      | 2 "      | 3        | 0       | 1       |
|                                        | 3 "      | 3        | 1       | 0       |                                      | 3 "      | 4        | 1       | 0       |
| 6 drs. burster.                        | 4 "      | 3        | 0       | 0       | 6 drs. burster.                      | 4 "      | 2        | 0       | 0       |
|                                        | 5 "      | 2        | 1       | 0       |                                      | 5 "      | 4        | 1       | 0       |
|                                        | 6 "      | 2        | 0       | 0       |                                      | 6 "      | 2        | 2       | 0       |
|                                        | 7 "      | 2        | 1       | 0       |                                      | 7 "      | 1        | 0       | 0       |
|                                        | 8 "      | 1        | 0       | 1       |                                      | 8 "      | 1        | 0       | 0       |

BOXER'S SHRAPNEL SHELL—*continued.*

June 29, 1864.

RANGE, 1,300 yards.

The target consisted of three lines of 9-foot targets, 5 in each line. 6 yards between the lines.

The shell to burst 10 yards in front of the first line of targets.

Five feet to ground.

|                                                                  |           | Through. | Lodged. | Struck. |                                                                |           | Through. | Lodged. | Struck. |
|------------------------------------------------------------------|-----------|----------|---------|---------|----------------------------------------------------------------|-----------|----------|---------|---------|
| Struck 5 ft. above<br>the ground.<br><br>12 drs. burster.        | 1st line. |          |         |         | Struck 4 ft. 6 in.<br>above the ground.<br><br>6 drs. burster. | 1st line. |          |         |         |
|                                                                  | 1 target  | 0        | 0       | 0       |                                                                | 1 target  | 0        | 0       | 0       |
|                                                                  | 2 "       | 0        | 0       | 0       |                                                                | 2 "       | 0        | 0       | 0       |
|                                                                  | 3 "       | 2        | 0       | 1       |                                                                | 3 "       | 43       | 1       | 1       |
|                                                                  | 4 "       | 49       | 0       | 7       |                                                                | 4 "       | 7        | 1       | 0       |
|                                                                  | 5 "       | 0        | 0       | 0       |                                                                | 5 "       | 0        | 0       | 0       |
|                                                                  | 2nd line. |          |         |         |                                                                | 2nd line. |          |         |         |
|                                                                  | 1 target  | 0        | 0       | 0       |                                                                | 1 target  | 1        | 0       | 0       |
|                                                                  | 2 "       | 3        | 1       | 1       |                                                                | 2 "       | 15       | 1       | 0       |
|                                                                  | 3 "       | 34       | 1       | 4       |                                                                | 3 "       | 30       | 4       | 0       |
|                                                                  | 4 "       | 10       | 0       | 2       |                                                                | 4 "       | 1        | 1       | 0       |
|                                                                  | 5 "       | 2        | 0       | 0       |                                                                | 5 "       | 0        | 0       | 0       |
|                                                                  | 3rd line. |          |         |         |                                                                | 3rd line. |          |         |         |
|                                                                  | 1 target  | 0        | 0       | 0       |                                                                | 1 target  | 0        | 0       | 0       |
|                                                                  | 2 "       | 5        | 1       | 3       |                                                                | 2 "       | 4        | 0       | 1       |
| Struck 10 ft. 6 in.<br>above the ground.<br><br>12 drs. burster. | 3 "       | 14       | 7       | 7       | Struck 4 ft. 2 in.<br>above the ground.<br><br>6 drs. burster. | 3 "       | 8        | 7       | 5       |
|                                                                  | 4 "       | 5        | 2       | 1       |                                                                | 4 "       | 7        | 4       | 2       |
|                                                                  | 5 "       | 1        | 0       | 1       |                                                                | 5 "       | 0        | 0       | 0       |
|                                                                  | 1st line. |          |         |         |                                                                | 1st line. |          |         |         |
|                                                                  | 1 target  | 1        | 0       | 0       |                                                                | 1 target  | 0        | 0       | 0       |
|                                                                  | 2 "       | 2        | 0       | 0       |                                                                | 2 "       | 21       | 0       | 0       |
|                                                                  | 3 "       | 3        | 1       | 0       |                                                                | 3 "       | 33       | 0       | 0       |
|                                                                  | 4 "       | 2        | 1       | 1       |                                                                | 4 "       | 2        | 0       | 0       |
|                                                                  | 5 "       | 1        | 1       | 0       |                                                                | 5 "       | 0        | 0       | 0       |
|                                                                  | 2nd line. |          |         |         |                                                                | 2nd line. |          |         |         |
|                                                                  | 1 target  | 0        | 0       | 0       |                                                                | 1 target  | 0        | 0       | 0       |
|                                                                  | 2 "       | 2        | 1       | 0       |                                                                | 2 "       | 2        | 0       | 0       |
|                                                                  | 3 "       | 2        | 1       | 0       |                                                                | 3 "       | 23       | 1       | 1       |
|                                                                  | 4 "       | 2        | 0       | 0       |                                                                | 4 "       | 15       | 2       | 1       |
|                                                                  | 5 "       | 0        | 0       | 1       |                                                                | 5 "       | 0        | 0       | 0       |
|                                                                  | 3rd line. |          |         |         |                                                                | 3rd line. |          |         |         |
| Struck 15 ft. 7 in.<br>above the ground.<br><br>12 drs. burster. | 1 target  | 0        | 0       | 0       | Struck 2 ft. 6 in.<br>above the ground.<br><br>6 drs. burster. | 1 target  | 1        | 0       | 0       |
|                                                                  | 2 "       | 2        | 0       | 0       |                                                                | 2 "       | 11       | 4       | 2       |
|                                                                  | 3 "       | 2        | 0       | 0       |                                                                | 3 "       | 19       | 4       | 0       |
|                                                                  | 4 "       | 0        | 1       | 1       |                                                                | 4 "       | 1        | 0       | 0       |
|                                                                  | 5 "       | 0        | 1       | 0       |                                                                | 5 "       | 1        | 0       | 1       |
|                                                                  | 1st line. |          |         |         |                                                                | 1st line. |          |         |         |
|                                                                  | 1 target  | 2        | 0       | 0       |                                                                | 1 target  | 0        | 0       | 0       |
|                                                                  | 2 "       | 4        | 2       | 0       |                                                                | 2 "       | 2        | 0       | 0       |
|                                                                  | 3 "       | 2        | 1       | 1       |                                                                | 3 "       | 11       | 1       | 2       |
|                                                                  | 4 "       | 2        | 0       | 0       |                                                                | 4 "       | 38       | 3       | 1       |
|                                                                  | 5 "       | 2        | 0       | 0       |                                                                | 5 "       | 2        | 0       | 1       |
|                                                                  | 2nd line. |          |         |         |                                                                | 2nd line. |          |         |         |
|                                                                  | 1 target  | 1        | 1       | 0       |                                                                | 1 target  | 0        | 0       | 0       |
|                                                                  | 2 "       | 0        | 1       | 1       |                                                                | 2 "       | 0        | 0       | 3       |
|                                                                  | 3 "       | 0        | 0       | 1       |                                                                | 3 "       | 11       | 1       | 2       |
|                                                                  | 4 "       | 0        | 0       | 0       |                                                                | 4 "       | 25       | 2       | 0       |
|                                                                  | 5 "       | 2        | 0       | 0       |                                                                | 5 "       | 2        | 0       | 0       |
|                                                                  | 3rd line. |          |         |         |                                                                | 3rd line. |          |         |         |
|                                                                  | 1 target  | 0        | 0       | 0       |                                                                | 1 target  | 0        | 0       | 0       |
|                                                                  | 2 "       | 0        | 1       | 2       |                                                                | 2 "       | 1        | 1       | 0       |
|                                                                  | 3 "       | 0        | 0       | 1       |                                                                | 3 "       | 0        | 5       | 4       |
|                                                                  | 4 "       | 4        | 1       | 0       |                                                                | 4 "       | 3        | 9       | 5       |
|                                                                  | 5 "       | 0        | 0       | 0       |                                                                | 5 "       | 1        | 0       | 0       |



BOXER'S SHRAPNEL SHELL—*continued.*

To strike the screen from 5 feet to 10 feet from the ground.

| —                                                            | —         | Through. | Lodged. | Struck. | —                                                                   | —         | Through. | Lodged. | Struck. |
|--------------------------------------------------------------|-----------|----------|---------|---------|---------------------------------------------------------------------|-----------|----------|---------|---------|
| Struck 7 ft. 10 in.<br>above the ground.<br>12 drs. burster. | 1st line. |          |         |         | Shell struck 7 ft.<br>6 in. above the<br>ground.<br>6 drs. burster. | 1st line. |          |         |         |
|                                                              | 1 target  | 0        | 0       | 0       |                                                                     | 1 target  | 0        | 0       | 0       |
|                                                              | 2 "       | 6        | 0       | 0       |                                                                     | 2 "       | 45       | 0       | 3       |
|                                                              | 3 "       | 50       | 1       | 0       |                                                                     | 3 "       | 2        | 0       | 0       |
|                                                              | 4 "       | 3        | 0       | 1       |                                                                     | 4 "       | 0        | 0       | 0       |
|                                                              | 5 "       | 0        | 0       | 0       |                                                                     | 5 "       | 0        | 0       | 0       |
|                                                              | 2nd line. |          |         |         |                                                                     | 2nd line. |          |         |         |
|                                                              | 1 target  | 0        | 0       | 0       |                                                                     | 1 target  | 0        | 0       | 0       |
|                                                              | 2 "       | 6        | 3       | 0       |                                                                     | 2 "       | 35       | 4       | 8       |
|                                                              | 3 "       | 42       | 2       | 3       |                                                                     | 3 "       | 12       | 0       | 1       |
|                                                              | 4 "       | 8        | 0       | 2       |                                                                     | 4 "       | 0        | 0       | 0       |
|                                                              | 5 "       | 0        | 0       | 1       |                                                                     | 5 "       | 0        | 0       | 0       |
|                                                              | 3rd line. |          |         |         |                                                                     | 3rd line. |          |         |         |
|                                                              | 1 target  | 0        | 0       | 0       |                                                                     | 1 target  | 0        | 1       | 0       |
|                                                              | 2 "       | 8        | 1       | 0       |                                                                     | 2 "       | 25       | 0       | 6       |
| Struck 6 ft. 6 in.<br>above the ground.<br>12 drs. burster.  | 3 "       | 16       | 2       | 7       | Struck 9 ft. above<br>the ground.<br>6 drs. burster.                | 3 "       | 6        | 3       | 0       |
|                                                              | 4 "       | 6        | 0       | 0       |                                                                     | 4 "       | 0        | 0       | 0       |
|                                                              | 5 "       | 2        | 0       | 0       |                                                                     | 5 "       | 0        | 0       | 0       |
|                                                              | 1st line. |          |         |         |                                                                     | 1st line. |          |         |         |
|                                                              | 1 target  | 0        | 0       | 0       |                                                                     | 1 target  | 0        | 0       | 0       |
|                                                              | 2 "       | 9        | 2       | 2       |                                                                     | 2 "       | 3        | 0       | 0       |
|                                                              | 3 "       | 41       | 3       | 2       |                                                                     | 3 "       | 35       | 0       | 0       |
|                                                              | 4 "       | 0        | 0       | 0       |                                                                     | 4 "       | 1        | 0       | 0       |
|                                                              | 5 "       | 0        | 0       | 0       |                                                                     | 5 "       | 0        | 0       | 0       |
|                                                              | 2nd line. |          |         |         |                                                                     | 2nd line. |          |         |         |
|                                                              | 1 target  | 0        | 0       | 0       |                                                                     | 1 target  | 0        | 0       | 0       |
|                                                              | 2 "       | 10       | 6       | 0       |                                                                     | 2 "       | 2        | 0       | 0       |
|                                                              | 3 "       | 17       | 7       | 2       |                                                                     | 3 "       | 21       | 2       | 3       |
|                                                              | 4 "       | 0        | 0       | 0       |                                                                     | 4 "       | 9        | 6       | 5       |
|                                                              | 5 "       | 0        | 0       | 0       |                                                                     | 5 "       | 0        | 0       | 0       |
| Struck 5 ft. 1 in.<br>above the ground.<br>12 drs. burster.  | 3rd line. |          |         |         |                                                                     | 3rd line. |          |         |         |
|                                                              | 1 target  | 0        | 0       | 0       |                                                                     | 1 target  | 0        | 0       | 0       |
|                                                              | 2 "       | 0        | 0       | 0       |                                                                     | 2 "       | 0        | 0       | 0       |
|                                                              | 3 "       | 9        | 0       | 1       |                                                                     | 3 "       | 7        | 2       | 1       |
|                                                              | 4 "       | 9        | 1       | 2       |                                                                     | 4 "       | 15       | 1       | 1       |
|                                                              | 5 "       | 2        | 1       | 0       |                                                                     | 5 "       | 0        | 0       | 0       |
|                                                              | 1st line. |          |         |         |                                                                     | 1st line. |          |         |         |
|                                                              | 1 target  | 0        | 0       | 0       |                                                                     | 1 target  | 0        | 0       | 0       |
|                                                              | 2 "       | 9        | 2       | 0       |                                                                     | 2 "       | 3        | 0       | 1       |
|                                                              | 3 "       | 45       | 2       | 2       |                                                                     | 3 "       | 33       | 0       | 3       |
|                                                              | 4 "       | 6        | 0       | 0       |                                                                     | 4 "       | 0        | 0       | 0       |
|                                                              | 5 "       | 0        | 0       | 0       |                                                                     | 5 "       | 0        | 0       | 0       |
|                                                              | 2nd line. |          |         |         |                                                                     | 2nd line. |          |         |         |
|                                                              | 1 target  | 0        | 0       | 0       |                                                                     | 1 target  | 0        | 0       | 0       |
|                                                              | 2 "       | 5        | 1       | 0       |                                                                     | 2 "       | 0        | 0       | 0       |
| Struck 10 ft. above<br>the ground.<br>6 drs. burster.        | 3 "       | 28       | 3       | 1       |                                                                     | 3 "       | 24       | 0       | 4       |
|                                                              | 4 "       | 13       | 2       | 0       |                                                                     | 4 "       | 8        | 1       | 2       |
|                                                              | 5 "       | 0        | 0       | 0       |                                                                     | 5 "       | 0        | 0       | 0       |
|                                                              | 3rd line. |          |         |         |                                                                     | 3rd line. |          |         |         |
|                                                              | 1 target  | 1        | 0       | 0       |                                                                     | 1 target  | 0        | 0       | 0       |
|                                                              | 2 "       | 2        | 1       | 0       |                                                                     | 2 "       | 3        | 1       | 0       |
|                                                              | 3 "       | 12       | 2       | 3       |                                                                     | 3 "       | 16       | 5       | 7       |
|                                                              | 4 "       | 11       | 1       | 1       |                                                                     | 4 "       | 5        | 1       | 0       |
|                                                              | 5 "       | 0        | 0       | 0       |                                                                     | 5 "       | 0        | 0       | 0       |

BOXER'S SHRAPNEL SHELL—*continued.*

September 8, 1864.

Shell to burst 100 yards in front of target, and to strike from 9 feet to the ground.

|                                                           |           | Through. | Lodged. | Struck. |                                                              |           | Through. | Lodged. | Struck. |
|-----------------------------------------------------------|-----------|----------|---------|---------|--------------------------------------------------------------|-----------|----------|---------|---------|
| Struck 5 ft. above the ground.<br>12 drs. burster.        | 1st line. |          |         |         | Struck 5 feet 6 inches above the ground.<br>6 drs. burster.  | 1st line. |          |         |         |
|                                                           | 1 target  | 1        | 1       | 0       |                                                              | 1 target  | 1        | 0       | 0       |
|                                                           | 2 "       | 1        | 1       | 0       |                                                              | 2 "       | 1        | 0       | 1       |
|                                                           | 3 "       | 1        | 0       | 0       |                                                              | 3 "       | 2        | 0       | 0       |
|                                                           | 4 "       | 1        | 1       | 0       |                                                              | 4 "       | 1        | 0       | 0       |
|                                                           | 5 "       | 2        | 0       | 0       |                                                              | 5 "       | 1        | 0       | 0       |
|                                                           | 2nd line. |          |         |         |                                                              | 2nd line. |          |         |         |
|                                                           | 1 target  | 0        | 1       | 0       |                                                              | 1 target  | 0        | 0       | 0       |
|                                                           | 2 "       | 4        | 0       | 0       |                                                              | 2 "       | 1        | 0       | 0       |
|                                                           | 3 "       | 2        | 0       | 0       |                                                              | 3 "       | 2        | 0       | 0       |
| Struck 1 ft. 2 in. above the ground.<br>12 drs. burster.  | 4 "       | 1        | 0       | 0       | Struck 2 feet above the ground.<br>6 drs. burster.           | 4 "       | 0        | 0       | 0       |
|                                                           | 5 "       | 1        | 1       | 0       |                                                              | 5 "       | 1        | 1       | 0       |
|                                                           | 3rd line. |          |         |         |                                                              | 3rd line. |          |         |         |
|                                                           | 1 "       | 0        | 0       | 0       |                                                              | 1 target  | 0        | 0       | 0       |
|                                                           | 2 "       | 0        | 2       | 0       |                                                              | 2 "       | 0        | 0       | 0       |
|                                                           | 3 "       | 0        | 0       | 2       |                                                              | 3 "       | 0        | 2       | 0       |
|                                                           | 4 "       | 0        | 1       | 0       |                                                              | 4 "       | 0        | 0       | 0       |
|                                                           | 5 "       | 0        | 1       | 0       |                                                              | 5 "       | 0        | 0       | 1       |
|                                                           | 1st line. |          |         |         |                                                              | 1st line. |          |         |         |
|                                                           | 1 target  | 1        | 0       | 0       |                                                              | 1 target  | 0        | 0       | 0       |
| Struck 1 ft. 4 in. above the ground.<br>12 drs. burster.  | 2 "       | 1        | 0       | 1       | Struck 2 feet 10 inches above the ground.<br>6 drs. burster. | 2 "       | 2        | 0       | 0       |
|                                                           | 3 "       | 2        | 0       | 0       |                                                              | 3 "       | 3        | 1       | 1       |
|                                                           | 4 "       | 1        | 0       | 0       |                                                              | 4 "       | 0        | 0       | 1       |
|                                                           | 5 "       | 1        | 0       | 0       |                                                              | 5 "       | 1        | 0       | 1       |
|                                                           | 2nd line. |          |         |         |                                                              | 2nd line. |          |         |         |
|                                                           | 1 target  | 0        | 0       | 0       |                                                              | 1 target  | 0        | 0       | 0       |
|                                                           | 2 "       | 1        | 0       | 0       |                                                              | 2 "       | 1        | 0       | 1       |
|                                                           | 3 "       | 2        | 0       | 0       |                                                              | 3 "       | 3        | 0       | 0       |
|                                                           | 4 "       | 0        | 0       | 0       |                                                              | 4 "       | 1        | 0       | 1       |
|                                                           | 5 "       | 1        | 1       | 0       |                                                              | 5 "       | 1        | 0       | 0       |
| Struck 8 ft. 2 in. above the ground.<br>12 drs. burster.* | 3rd line. |          |         |         | Struck 5 feet 10 inches above the ground.<br>6 drs. burster. | 3rd line. |          |         |         |
|                                                           | 1 target  | 0        | 0       | 0       |                                                              | 1 target  | 0        | 0       | 0       |
|                                                           | 2 "       | 0        | 0       | 0       |                                                              | 2 "       | 0        | 0       | 0       |
|                                                           | 3 "       | 0        | 2       | 0       |                                                              | 3 "       | 0        | 0       | 0       |
|                                                           | 4 "       | 0        | 0       | 0       |                                                              | 4 "       | 0        | 0       | 0       |
|                                                           | 5 "       | 0        | 0       | 1       |                                                              | 5 "       | 0        | 0       | 0       |
|                                                           | 1st line. |          |         |         |                                                              | 1st line. |          |         |         |
|                                                           | 1 target  | 3        | 1       | 1       |                                                              | 1 target  | 2        | 1       | 0       |
|                                                           | 2 "       | 2        | 0       | 1       |                                                              | 2 "       | 1        | 1       | 0       |
|                                                           | 3 "       | 0        | 1       | 0       |                                                              | 3 "       | 2        | 0       | 0       |
|                                                           | 4 "       | 0        | 0       | 0       |                                                              | 4 "       | 2        | 1       | 0       |
|                                                           | 5 "       | 0        | 0       | 0       |                                                              | 5 "       | 1        | 0       | 0       |
|                                                           | 2nd line. |          |         |         |                                                              | 2nd line. |          |         |         |
|                                                           | 1 target  | 1        | 0       | 0       |                                                              | 1 target  | 2        | 1       | 0       |
|                                                           | 2 "       | 1        | 0       | 0       |                                                              | 2 "       | 3        | 0       | 0       |
|                                                           | 3 "       | 1        | 1       | 0       |                                                              | 3 "       | 1        | 0       | 1       |
|                                                           | 4 "       | 0        | 0       | 0       |                                                              | 4 "       | 1        | 0       | 0       |
|                                                           | 5 "       | 1        | 0       | 0       |                                                              | 5 "       | 0        | 0       | 0       |
|                                                           | 3rd line. |          |         |         |                                                              | 3rd line. |          |         |         |
|                                                           | 1 target  | 0        | 0       | 1       |                                                              | 1 target  | 0        | 0       | 0       |
|                                                           | 2 "       | 0        | 1       | 0       |                                                              | 2 "       | 0        | 2       | 2       |
|                                                           | 3 "       | 0        | 0       | 0       |                                                              | 3 "       | 0        | 2       | 0       |
|                                                           | 4 "       | 0        | 0       | 0       |                                                              | 4 "       | 0        | 2       | 0       |
|                                                           | 5 "       | 1        | 0       | 0       |                                                              | 5 "       | 0        | 0       | 0       |
|                                                           | 1st line. |          |         |         |                                                              | 1st line. |          |         |         |
|                                                           | 1 target  | 3        | 0       | 0       |                                                              | 1 target  | 3        | 0       | 0       |
|                                                           | 2 "       | 1        | 1       | 0       |                                                              | 2 "       | 2        | 0       | 0       |
|                                                           | 3 "       | 0        | 0       | 0       |                                                              | 3 "       | 2        | 0       | 0       |
|                                                           | 4 "       | 1        | 1       | 0       |                                                              | 4 "       | 3        | 1       | 0       |
|                                                           | 5 "       | 2        | 0       | 0       |                                                              | 5 "       | 4        | 0       | 0       |
|                                                           | 2nd line. |          |         |         |                                                              | 2nd line. |          |         |         |
|                                                           | 1 target  | 1        | 0       | 0       |                                                              | 1 target  | 2        | 1       | 0       |
|                                                           | 2 "       | 1        | 0       | 0       |                                                              | 2 "       | 1        | 0       | 1       |
|                                                           | 3 "       | 0        | 0       | 0       |                                                              | 3 "       | 2        | 0       | 0       |
|                                                           | 4 "       | 1        | 0       | 0       |                                                              | 4 "       | 1        | 0       | 0       |
|                                                           | 5 "       | 0        | 0       | 0       |                                                              | 5 "       | 2        | 0       | 0       |
|                                                           | 3rd line. |          |         |         |                                                              | 3rd line. |          |         |         |
|                                                           | 1 target  | 0        | 0       | 0       |                                                              | 1 target  | 0        | 1       | 1       |
|                                                           | 2 "       | 0        | 0       | 0       |                                                              | 2 "       | 0        | 1       | 0       |
|                                                           | 3 "       | 1        | 0       | 0       |                                                              | 3 "       | 0        | 1       | 0       |
|                                                           | 4 "       | 0        | 0       | 0       |                                                              | 4 "       | 0        | 0       | 1       |
|                                                           | 5 "       | 0        | 0       | 1       |                                                              | 5 "       | 0        | 2       | 0       |



## BOXER'S SHRAPNEL SHELL—continued.

Shell to burst 100 yards in front of target. From 9 to 18 feet from the ground.

|                                                               |           | Through. | Lodged. | Struck. |                                                                     |           | Through. | Lodged. | Struck. |
|---------------------------------------------------------------|-----------|----------|---------|---------|---------------------------------------------------------------------|-----------|----------|---------|---------|
| Struck 15 ft. 7 in.<br>above the ground.<br>12 drs. burster.* | 1st line. |          |         |         | Struck 16 feet 2<br>inches above the<br>ground.<br>6 drs. burster.  | 1st line. |          |         |         |
|                                                               | 1 target  | 2        | 0       | 0       |                                                                     | 1 target  | 1        | 0       | 0       |
|                                                               | 2 "       | 4        | 2       | 0       |                                                                     | 2 "       | 2        | 3       | 0       |
|                                                               | 3 "       | 2        | 1       | 1       |                                                                     | 3 "       | 0        | 0       | 0       |
|                                                               | 4 "       | 2        | 0       | 0       |                                                                     | 4 "       | 3        | 0       | 0       |
|                                                               | 5 "       | 2        | 0       | 0       |                                                                     | 5 "       | 3        | 0       | 0       |
|                                                               | 2nd line. |          |         |         |                                                                     | 2nd line. |          |         |         |
|                                                               | 1 target  | 1        | 1       | 0       |                                                                     | 1 target  | 2        | 0       | 0       |
|                                                               | 2 "       | 0        | 1       | 1       |                                                                     | 2 "       | 2        | 1       | 0       |
|                                                               | 3 "       | 0        | 0       | 1       |                                                                     | 3 "       | 0        | 0       | 0       |
|                                                               | 4 "       | 0        | 0       | 0       |                                                                     | 4 "       | 3        | 0       | 0       |
|                                                               | 5 "       | 2        | 0       | 0       |                                                                     | 5 "       | 3        | 1       | 0       |
|                                                               | 3rd line. |          |         |         |                                                                     | 3rd line. |          |         |         |
|                                                               | 1 target  | 0        | 0       | 0       |                                                                     | 1 target  | 1        | 0       | 0       |
|                                                               | 2 "       | 0        | 1       | 2       |                                                                     | 2 "       | 0        | 0       | 0       |
| Struck 10 ft. 6 in.<br>above the ground.<br>12 drs. burster.* | 3 "       | 0        | 0       | 1       | Struck 11 feet 6<br>inches above the<br>ground.<br>6 drs. burster.  | 3 "       | 0        | 0       | 0       |
|                                                               | 4 "       | 4        | 1       | 0       |                                                                     | 4 "       | 1        | 1       | 0       |
|                                                               | 5 "       | 0        | 0       | 0       |                                                                     | 5 "       | 0        | 0       | 0       |
|                                                               | 1st line. |          |         |         |                                                                     | 1st line. |          |         |         |
|                                                               | 1 target  | 1        | 0       | 0       |                                                                     | 1 target  | 3        | 0       | 1       |
|                                                               | 2 "       | 2        | 0       | 0       |                                                                     | 2 "       | 2        | 0       | 1       |
|                                                               | 3 "       | 3        | 1       | 0       |                                                                     | 3 "       | 2        | 1       | 0       |
|                                                               | 4 "       | 2        | 1       | 1*      |                                                                     | 4 "       | 3        | 0       | 0       |
|                                                               | 5 "       | 1        | 1       | 0       |                                                                     | 5 "       | 4        | 1       | 0       |
|                                                               | 2nd line. |          |         |         |                                                                     | 2nd line. |          |         |         |
|                                                               | 1 target  | 0        | 0       | 0       |                                                                     | 1 target  | 3        | 1       | 1       |
|                                                               | 2 "       | 2        | 1       | 0       |                                                                     | 2 "       | 1        | 1       | 0       |
|                                                               | 3 "       | 2        | 1       | 0       |                                                                     | 3 "       | 2        | 0       | 0       |
|                                                               | 4 "       | 2        | 0       | 0       |                                                                     | 4 "       | 2        | 0       | 1       |
|                                                               | 5 "       | 0        | 0       | 1       |                                                                     | 5 "       | 1        | 0       | 0       |
| Struck 10 ft. 1 in.<br>above the ground.<br>12 drs. burster.* | 3rd line. |          |         |         |                                                                     | 3rd line. |          |         |         |
|                                                               | 1 target  | 0        | 0       | 0       |                                                                     | 1 target  | 0        | 2       | 0       |
|                                                               | 2 "       | 2        | 0       | 0       |                                                                     | 2 "       | 1        | 1       | 0       |
|                                                               | 3 "       | 2        | 0       | 0       |                                                                     | 3 "       | 0        | 1       | 0       |
|                                                               | 4 "       | 0        | 1       | 1       |                                                                     | 4 "       | 1        | 0       | 0       |
|                                                               | 5 "       | 0        | 1       | 0       |                                                                     | 5 "       | 0        | 2       | 0       |
|                                                               | 1st line. |          |         |         | Struck 10 feet<br>above the ground.<br>6 drs. burster.              | 1st line. |          |         |         |
|                                                               | 1 target  | 2        | 0       | 0       |                                                                     | 1 target  | 1        | 0       | 0       |
|                                                               | 2 "       | 4        | 2       | 0       |                                                                     | 2 "       | 1        | 1       | 0       |
|                                                               | 3 "       | 1        | 1       | 0       |                                                                     | 3 "       | 1        | 0       | 0       |
|                                                               | 4 "       | 1        | 0       | 0       |                                                                     | 4 "       | 0        | 0       | 0       |
|                                                               | 5 "       | 1        | 0       | 0       |                                                                     | 5 "       | 3        | 0       | 0       |
|                                                               | 2nd line. |          |         |         |                                                                     | 2nd line. |          |         |         |
|                                                               | 1 target  | 0        | 0       | 0       |                                                                     | 1 target  | 2        | 0       | 0       |
|                                                               | 2 "       | 1        | 0       | 0       |                                                                     | 2 "       | 0        | 0       | 0       |
|                                                               | 3 "       | 0        | 0       | 0       |                                                                     | 3 "       | 1        | 0       | 1       |
|                                                               | 4 "       | 2        | 0       | 0       |                                                                     | 4 "       | 1        | 0       | 0       |
|                                                               | 5 "       | 0        | 1       | 0       |                                                                     | 5 "       | 3        | 2       | 0       |
|                                                               | 3rd line. |          |         |         |                                                                     | 3rd line. |          |         |         |
|                                                               | 1 target  | 0        | 0       | 0       |                                                                     | 1 target  | 0        | 2       | 2       |
|                                                               | 2 "       | 0        | 0       | 0       |                                                                     | 2 "       | 0        | 0       | 0       |
| Struck 15 ft. 3 in.<br>above the ground.<br>12 drs. burster.* | 3 "       | 0        | 0       | 0       |                                                                     | 3 "       | 1        | 0       | 1       |
|                                                               | 4 "       | 1        | 0       | 0       |                                                                     | 4 "       | 0        | 0       | 0       |
|                                                               | 5 "       | 0        | 0       | 1       |                                                                     | 5 "       | 1        | 1       | 0       |
|                                                               | 1st line. |          |         |         | Struck 14 feet 3<br>inches above the<br>ground.<br>6 drs. burster.* | 1st line. |          |         |         |
|                                                               | 1 target  | 1        | 1       | 0       |                                                                     | 1 target  | 1        | 1       | 0       |
|                                                               | 2 "       | 3        | 0       | 0       |                                                                     | 2 "       | 2        | 0       | 0       |
|                                                               | 3 "       | 2        | 0       | 0       |                                                                     | 3 "       | 1        | 1       | 0       |
|                                                               | 4 "       | 0        | 1       | 0       |                                                                     | 4 "       | 0        | 0       | 0       |
|                                                               | 5 "       | 3        | 0       | 0       |                                                                     | 5 "       | 5        | 0       | 0       |
|                                                               | 2nd line. |          |         |         |                                                                     | 2nd line. |          |         |         |
|                                                               | 1 target  | 0        | 0       | 0       |                                                                     | 1 target  | 2        | 0       | 0       |
|                                                               | 2 "       | 2        | 0       | 1       |                                                                     | 2 "       | 4        | 0       | 0       |
|                                                               | 3 "       | 0        | 0       | 1       |                                                                     | 3 "       | 1        | 1       | 0       |
|                                                               | 4 "       | 0        | 1       | 0       |                                                                     | 4 "       | 0        | 0       | 0       |
|                                                               | 5 "       | 0        | 0       | 0       |                                                                     | 5 "       | 4        | 1       | 0       |
|                                                               | 3rd line. |          |         |         |                                                                     | 3rd line. |          |         |         |
|                                                               | 1 target  | 0        | 0       | 1       |                                                                     | 1 target  | 0        | 0       | 0       |
|                                                               | 2 "       | 0        | 0       | 0       |                                                                     | 2 "       | 1        | 0       | 0       |
|                                                               | 3 "       | 0        | 0       | 0       |                                                                     | 3 "       | 1        | 1       | 0       |
|                                                               | 4 "       | 0        | 1       | 0       |                                                                     | 4 "       | 0        | 0       | 0       |
|                                                               | 5 "       | 0        | 0       | 0       |                                                                     | 5 "       | 1        | 0       | 1       |

BOXER'S SHRAPNEL SHELL—continued.

September 13, 1864.

RANGE, 1,300 yards.

Shrapnel shell with percussion fuzes, fired so as to strike the ground at different distances in front of the targets, and burst on raze.

The targets consisted of 3 lines of 2-inch deal targets 9 × 9 feet, 5 in each line ; 6 yards interval between the lines.

| —                                              | —         | Through. | Lodged. | Struck. | —                                              | —         | Through. | Lodged. | Struck. |
|------------------------------------------------|-----------|----------|---------|---------|------------------------------------------------|-----------|----------|---------|---------|
| Struck 85 yards short.<br><br>12 drs. burster. | 1st line. |          |         |         | Struck 62 yards short.<br><br>12 drs. burster. | 1st line. |          |         |         |
|                                                | 1 target  | } Nil.   | Nil.    | Nil.    |                                                | 1 target  | } Nil.   | Nil.    | Nil.    |
|                                                | 2 "       |          |         |         |                                                |           |          |         |         |
|                                                | 3 "       |          |         |         |                                                |           |          |         |         |
|                                                | 4 "       |          |         |         |                                                |           |          |         |         |
|                                                | 5 "       |          |         |         |                                                |           |          |         |         |
|                                                | 2nd line. |          |         |         |                                                | 2nd line. |          |         |         |
|                                                | 1 target  | } Nil.   | Nil.    | Nil.    |                                                | 1 target  | } Nil.   | Nil.    | Nil.    |
|                                                | 2 "       |          |         |         |                                                |           |          |         |         |
|                                                | 3 "       |          |         |         |                                                |           |          |         |         |
|                                                | 4 "       |          |         |         |                                                |           |          |         |         |
|                                                | 5 "       |          |         |         |                                                |           |          |         |         |
|                                                | 3rd line. |          |         |         |                                                | 3rd line. |          |         |         |
|                                                | 1 target  | } Nil.   | Nil.    | Nil.    |                                                | 1 target  | } Nil.   | Nil.    | Nil.    |
|                                                | 2 "       |          |         |         |                                                |           |          |         |         |
| 3 "                                            |           |          |         |         |                                                |           |          |         |         |
| 4 "                                            |           |          |         |         |                                                |           |          |         |         |
| 5 "                                            |           |          |         |         |                                                |           |          |         |         |
| Struck 75 yards short.<br><br>12 drs. burster. | 1st line. |          |         |         | Struck 36 yards short.<br><br>12 drs. burster. | 1st line. |          |         |         |
|                                                | 1 target  | 0        | 0       | 0       |                                                | 1 target  | 0        | 0       | 0       |
|                                                | 2 "       | 0        | 0       | 0       |                                                | 2 "       | 0        | 0       | 0       |
|                                                | 3 "       | 2        | 0       | 0       |                                                | 3 "       | 2        | 0       | 0       |
|                                                | 4 "       | 0        | 0       | 0       |                                                | 4 "       | 2        | 0       | 0       |
|                                                | 5 "       | 0        | 0       | 0       |                                                | 5 "       | 0        | 0       | 0       |
|                                                | 2nd line. |          |         |         |                                                | 2nd line. |          |         |         |
|                                                | 1 target  | 0        | 0       | 0       |                                                | 1 target  | } Nil.   | Nil.    | Nil.    |
|                                                | 2 "       | 0        | 0       | 0       |                                                | 2 "       |          |         |         |
|                                                | 3 "       | 2        | 0       | 0       |                                                | 3 "       |          |         |         |
|                                                | 4 "       | 0        | 0       | 0       |                                                | 4 "       |          |         |         |
|                                                | 5 "       | 0        | 0       | 0       |                                                | 5 "       |          |         |         |
|                                                | 3rd line. |          |         |         |                                                | 3rd line. |          |         |         |
|                                                | 1 target  | } Nil.   | Nil.    | Nil.    |                                                | 1 target  | } Nil.   | Nil.    | Nil.    |
|                                                | 2 "       |          |         |         |                                                |           |          |         |         |
| 3 "                                            |           |          |         |         |                                                |           |          |         |         |
| 4 "                                            |           |          |         |         |                                                |           |          |         |         |
| 5 "                                            |           |          |         |         |                                                |           |          |         |         |

| —                       | —         | Through. | Lodged. | Struck. |
|-------------------------|-----------|----------|---------|---------|
| Struck 104 yards short. | 1st line. |          |         |         |
|                         | 1 target  | } Nil.   | Nil.    | Nil.    |
|                         | 2 "       |          |         |         |
|                         | 3 "       |          |         |         |
|                         | 4 "       |          |         |         |
|                         | 5 "       |          |         |         |
|                         | 2nd line. |          |         |         |
|                         | 1 target  | } Nil.   | Nil.    | Nil.    |
|                         | 2 "       |          |         |         |
|                         | 3 "       |          |         |         |
|                         | 4 "       |          |         |         |
|                         | 5 "       |          |         |         |
|                         | 3rd line. |          |         |         |
|                         | 1 target  | } Nil.   | Nil.    | Nil.    |
|                         | 2 "       |          |         |         |
|                         | 3 "       |          |         |         |
|                         | 4 "       |          |         |         |
|                         | 5 "       |          |         |         |



## BOXER'S SHRAPNEL SHELL—continued.

September 13, 1864.

RANGE, 1,300 yards.

Shrapnel shell with percussion fuzes, fired so as to strike the ground at different distances in front of the targets.

The targets consisted of 3 lines of 2-inch deal targets, 9 × 9 feet; 5 in each line; 6 yards interval between the lines.

|                         |           | Through. | Lodged. | Struck. |                        |           | Through. | Lodged. | Struck. |
|-------------------------|-----------|----------|---------|---------|------------------------|-----------|----------|---------|---------|
|                         | 1st line. |          |         |         |                        | 1st line. |          |         |         |
| Struck 112 yards short. | 1 target  | 0        | 1       | 1       | Struck 36 yards short. | 1 target  | 0        | 0       | 0       |
|                         | 2 "       | 0        | 0       | 0       |                        | 2 "       | 0        | 0       | 0       |
|                         | 3 "       | 0        | 1       | 0       |                        | 3 "       | 2        | 0       | 0       |
| 6 drs. burster.         | 4 "       | 0        | 0       | 0       | 6 drs. burster.        | 4 "       | 2        | 0       | 0       |
|                         | 5 "       | 0        | 0       | 0       |                        | 5 "       | 0        | 0       | 0       |
|                         | 2nd line. |          |         |         |                        | 2nd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                        | 1 target  | 0        | 0       | 0       |
|                         | 2 "       | 0        | 0       | 0       |                        | 2 "       | 2        | 0       | 0       |
|                         | 3 "       | 0        | 0       | 0       |                        | 3 "       | 1        | 0       | 0       |
|                         | 4 "       | 0        | 0       | 0       |                        | 4 "       | 0        | 0       | 0       |
|                         | 5 "       | 0        | 0       | 0       |                        | 5 "       | 0        | 0       | 0       |
|                         | 3rd line. |          |         |         |                        | 3rd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                        | 1 target  | 0        | 0       | 0       |
|                         | 2 "       | 0        | 0       | 0       |                        | 2 "       | 0        | 0       | 0       |
|                         | 3 "       | 0        | 0       | 0       |                        | 3 "       | 0        | 0       | 0       |
| One shell blind         | 4 "       | 0        | 0       | 0       |                        | 4 "       | 1        | 0       | 0       |
|                         | 5 "       | 0        | 0       | 0       |                        | 5 "       | 0        | 0       | 0       |
|                         | 1st line. |          |         |         |                        | 1st line. |          |         |         |
| Struck 75 yards short.  | 1 target  | 0        | 0       | 0       | Struck 61 yards short. | 1 target  | } Nil.   | } Nil.  | } Nil.  |
|                         | 2 "       | 0        | 0       | 0       |                        | 2 "       |          |         |         |
|                         | 3 "       | 2        | 0       | 0       |                        | 3 "       |          |         |         |
| 6 drs. burster.         | 4 "       | 0        | 0       | 0       | 6 drs. burster.        | 4 "       |          |         |         |
|                         | 5 "       | 0        | 0       | 0       |                        | 5 "       |          |         |         |
|                         | 2nd line. |          |         |         |                        | 2nd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                        | 1 target  | } Nil.   | } Nil.  | } Nil.  |
|                         | 2 "       | 0        | 0       | 0       |                        | 2 "       |          |         |         |
|                         | 3 "       | 2        | 0       | 0       |                        | 3 "       |          |         |         |
|                         | 4 "       | 0        | 0       | 0       |                        | 4 "       |          |         |         |
|                         | 5 "       | 0        | 0       | 0       |                        | 5 "       |          |         |         |
|                         | 3rd line. |          |         |         |                        | 3rd line. |          |         |         |
|                         | 1 target  | } Nil.   | } Nil.  | } Nil.  |                        | 1 target  | } Nil.   | } Nil.  | } Nil.  |
|                         | 2 "       |          |         |         |                        | 2 "       |          |         |         |
|                         | 3 "       |          |         |         |                        | 3 "       |          |         |         |
|                         | 4 "       |          |         |         |                        | 4 "       |          |         |         |
|                         | 5 "       |          |         |         |                        | 5 "       |          |         |         |

|                        |           | Through. | Lodged. | Struck. |
|------------------------|-----------|----------|---------|---------|
|                        | 1st line. |          |         |         |
| Struck 80 yards short. | 1 target  | } Nil.   | } Nil.  | } Nil.  |
|                        | 2 "       |          |         |         |
|                        | 3 "       |          |         |         |
|                        | 4 "       |          |         |         |
| 6 drs. burster.        | 5 "       |          |         |         |
|                        | 2nd line. |          |         |         |
|                        | 1 target  | } Nil.   | } Nil.  | } Nil.  |
|                        | 2 "       |          |         |         |
|                        | 3 "       |          |         |         |
|                        | 4 "       |          |         |         |
|                        | 5 "       |          |         |         |
|                        | 3rd line. |          |         |         |
|                        | 1 target  | } Nil.   | } Nil.  | } Nil.  |
|                        | 2 "       |          |         |         |
|                        | 3 "       |          |         |         |
|                        | 4 "       |          |         |         |
|                        | 5 "       |          |         |         |

BOXER'S SHRAPNEL SHELL—*continued.*

September 14, 1864.

RANGE, 800 yards.

Shrapnel shell, with percussion fuzes, fired to strike the ground at different distances in front of the targets.

The target consisted of 7 deal targets,  $9' \times 9' \times 2''$ .

|                                            |          | Through. | Lodged. | Struck. |
|--------------------------------------------|----------|----------|---------|---------|
| Struck 26 yards short.<br>12 drs. burster. | 1 target | 0        | 0       | 0       |
|                                            | 2 "      | 1        | 0       | 1       |
|                                            | 3 "      | 13       | 0       | 0       |
|                                            | 4 "      | 23       | 0       | 0       |
|                                            | 5 "      | 0        | 1       | 0       |
|                                            | 6 "      | 2        | 0       | 0       |
|                                            | 7 "      | 0        | 0       | 0       |
| Struck 11 yards short.<br>12 drs. burster. | 1 target | 0        | 0       | 0       |
|                                            | 2 "      | 0        | 0       | 0       |
|                                            | 3 "      | 50       | 0       | 0       |
|                                            | 4 "      | 0        | 0       | 0       |
|                                            | 5 "      | 0        | 0       | 0       |
|                                            | 6 "      | 0        | 0       | 0       |
|                                            | 7 "      | 0        | 0       | 0       |
| Struck 35 yards short.<br>6 drs. burster.  | 1 target | 0        | 0       | 0       |
|                                            | 2 "      | 1        | 0       | 0       |
|                                            | 3 "      | 11       | 0       | 0       |
|                                            | 4 "      | 3        | 1       | 0       |
|                                            | 5 "      | 0        | 0       | 1       |
|                                            | 6 "      | 0        | 0       | 0       |
|                                            | 7 "      | 0        | 0       | 0       |
| Struck 38 yards short.<br>6 drs. burster.  | 1 target | 1        | 0       | 0       |
|                                            | 2 "      | 3        | 0       | 0       |
|                                            | 3 "      | 7        | 0       | 0       |
|                                            | 4 "      | 3        | 0       | 0       |
|                                            | 5 "      | 1        | 0       | 0       |
|                                            | 6 "      | 0        | 0       | 0       |
|                                            | 7 "      | 0        | 0       | 0       |

This practice was discontinued, as there were 9 blind shell in succession.



## FUZES.

*September 15th, 1864.*

## BOXER FUZE.

The time fuze was set at 0.5 of an inch, and the time of burning taken with stop clocks. Fuze driven with fuze composition.

Elevation of gun 3°.

| Stop Clocks. | 1st Round. | 2nd Round.  | 3rd Round. | 4th Round.  | 5th Round. |
|--------------|------------|-------------|------------|-------------|------------|
| No. 1 -      | Sec. 3.3   | Sec. Blind. | Sec. 3.2   | Sec. Blind. | Sec. 4.5   |
| No. 2 -      | 3.3        | Blind.      | 3.1        | Blind.      | 4.3        |
| No. 3 -      | 3.6        | Blind.      | 3.1        | Blind.      | 4.6        |

Elevation of gun 4°.

| Stop Clocks. | 1st Round. | 2nd Round. | 3rd Round. | 4th Round. | 5th Round. |
|--------------|------------|------------|------------|------------|------------|
| No. 1 -      | Sec. 3.3   | Sec. 3.2   | Sec. 2.9   | Sec. 3.0   | Sec. 2.9   |
| No. 2 -      | 3.2        | 3.3        | 3.0        | 2.6        | 2.6        |
| No. 3 -      | 3.2        | 3.2        | 3.1        | 2.9        | 2.8        |

## RED FUZE.

Boxer fuze set to 1.25 sec.

Elevation at 4°.

| Stop Clocks. | 1st Round. | 2nd Round. | 3rd Round. | 4th Round. | 5th Round. |
|--------------|------------|------------|------------|------------|------------|
| No. 1 -      | Sec. 1.4   | Sec. 1.7   | Sec. 1.6   | Sec. 1.4   | Sec. 1.5   |
| No. 2 -      | 1.7        | 1.6        | 1.6        | —          | 1.5        |
| No. 3 -      | 1.6        | 1.6        | 1.6        | 1.6        | 1.6        |

Percussion fuzes fired to graze on water.

|             | Elevation 0°. |        | Elevation 1°. |        | Elevation 2°. |        | Elevation 3°. |        | Elevation 4°. |        | Elevation 5°. |        | Elevation 6°. |        | Elevation 7°. |        |
|-------------|---------------|--------|---------------|--------|---------------|--------|---------------|--------|---------------|--------|---------------|--------|---------------|--------|---------------|--------|
|             | Good.         | Blind. | Good.         | Blind. | Good.         | Blind. | Good.         | Blind. | Good.         | Blind. | Good.         | Blind. | Good.         | Blind. | Good.         | Blind. |
| 1st round - | 1             | -      | 1             | -      | 1             | -      | 1             | -      | 1             | -      | 1             | -      | 1             | -      | 1             | -      |
| 2nd round - | 1             | -      | 1             | -      | 1             | -      | 1             | -      | 1             | -      | 1             | -      | 1             | -      | 1             | -      |

## RED FUZE.

Time fuzes set at 2.25 seconds.

Elevation of gun 5°.

| Stop Clocks. | 1st Round. | 2nd Round. | 3rd Round. | 4th Round. | 5th Round. |
|--------------|------------|------------|------------|------------|------------|
| No. 1 -      | Sec. 2.7   | Sec. 2.7   | Sec. 2.8   | Sec. 2.7   | Sec. 1.8   |
| No. 2 -      | 2.9        | 2.8        | 2.8        | 2.8        | 1.8        |
| No. 3 -      | 2.8        | 2.7        | 2.8        | 2.8        | 1.8        |

## BLACK FUZE.

Time fuzes set to 1.2 inches.

Elevation of gun 6°.

| Stop Clocks. | 1st Round. | 2nd Round. | 3rd Round. | 4th Round. | 5th Round. |
|--------------|------------|------------|------------|------------|------------|
| No. 1 -      | Sec. 7.2   | Sec. 6.7   | Sec. —     | Sec. 7.4   | Sec. 6.6   |
| No. 2 -      | 7.6        | 6.8        | 6.7        | 7.3        | 6.6        |
| No. 3 -      | 7.1        | 6.7        | 6.6        | 7.4        | 6.6        |

## RED FUZE.

Time fuzes set to 3.25 seconds.

Elevation of gun 6°.

| Stop Clocks. | 1st Round. | 2nd Round. | 3rd Round. | 4th Round. | 5th Round. |
|--------------|------------|------------|------------|------------|------------|
| No. 1 -      | Sec. 3.8   | Sec. 3.8   | Sec. 3.7   | Sec. 3.9   | Sec. 4.0   |
| No. 2 -      | 3.9        | 3.8        | 3.7        | 3.8        | 3.9        |
| No. 3 -      | 3.9        | 3.8        | 3.6        | 3.9        | 4.0        |

Percussion fuzes made to graze on sand.

|             | Elevation 0°. |        | Elevation 1°. |        | Elevation 2°. |        | Elevation 3°. |        | Elevation 4°. |        |
|-------------|---------------|--------|---------------|--------|---------------|--------|---------------|--------|---------------|--------|
|             | Good.         | Blind. | Good.         | Blind. | Good.         | Blind. | Good.         | Blind. | Good.         | Blind. |
| 1st round - | -             | 1      | -             | 1      | -             | 1      | 1             | -      | 1             | -      |
| 2nd round - | -             | 1      | -             | 1      | -             | 1      | 1             | -      | 1             | -      |

## ROUGH USAGE.

October 18, 1864.

The 12-pounders that had been in the muddy ditch all night were this morning taken out, and with the view of ascertaining which of the guns could be got ready for action in the shortest possible time, the following experiment was carried out:—

The three guns being in the condition that they were in when taken out of the ditch, viz., covered more or less with thick mud, and with their bores more or less full of the same, were placed on the sea wall, detachments told off for them, and ten rounds solid shot were fired from each as rapidly as possible, the time being taken from the word "load."

## RESULTS:—

|                        | Min. | Sec. |
|------------------------|------|------|
| Fired the 1st round in | 1    | 4    |
| " 10th "               | 5    | 10   |

NOTE.—There was no check whatever in firing these rounds.

## EFFECT OF PREMATURE BURSTING OF SHELL IN THE BORE.

- 4 Common shell,
- 5 Segment shell,

were burst as nearly as possible at the seat of the shot.

To ensure this a hole was bored in the base of the shell, and the lubricator and end of the cartridge removed so as to bring the cartridge in contact with the burster of the shell.

The bore was not damaged in the slightest degree. 10 rounds solid shot were fired at a target; the result showed that the accuracy of the gun was not impaired.

October 28th, 1864.

- 10 rounds solid shot,
- 10 " shrapnel shell,
- 10 " common shell,

which were placed in wet straw in April last, and periodically wetted with sea water, were fired to day.

The ammunition did not appear to be in any way damaged.

December 22, 1864.

The gun was laid on skidding on the sand, and fired at with solid shot from a 9-pounder Armstrong gun. Charge,  $1\frac{1}{4}$  lb. Range, 40 yards.

*1st Shot.*—Struck the gun on the chase, and made a small dent; the shot glanced off and struck the trunnion, broke it off and drove it 20 yards away; the trunnion coil was also broken and loosened.

The direction of the shot was at an angle of  $30^\circ$  with the axis of the gun.

*2nd Shot.*—Hit partially on the chase, partially on the skidding, made a slight dent, but merely rolled the gun round.

*3rd Shot.*—As the last shot merely grazed the gun a third was fired, which struck the gun on the chase and made a dent.

The gun was subsequently fired 4 rounds without difficulty.



## RAPID FIRING.

*April 19, 1864.*

200 rounds of solid shot were fired, not as a competition as to rapidity of firing, but the firing to be continuous, carried on as rapidly as service considerations would admit of.

The gun detachments consisted of six men each, and were relieved every 30 rounds. In this detachment No. 3 was a civilian and was not relieved with the detachments.

The position of the guns was determined by lot.

The gun detachments and officers were selected also by lot.

The time taken in firing the 200 rounds was as follows:—

1 hour 12 minutes.

At the conclusion of the firing the gun fired 8 rounds of common shell (blind) at 9-foot targets, 300 yards range, to hit the bull's eye. Three first rounds trial shots; five last recorded.

1. 26·5 inches from centre.
2. 21·5       "       "
3. 5·0       "       "
4. 10·5       "       "
5. 12·0       "       "

*May 19, 1864.*

99 rounds solid shot were fired entirely by men of the Royal Artillery, the gun detachments being changed every 20 rounds until 60 rounds had been fired, and afterwards every 13 until the conclusion of the experiment.

One 6-foot floating target. Range, 1,200 yards.  
Elevation, 2° 20'.

The times were as follows:—

|                |   | Min. | Sec.  |
|----------------|---|------|-------|
| 1st 20 rounds  | - | -    | 9 45  |
| 2nd 20       " | - | -    | 10 45 |
| 3rd 20       " | - | -    | 15 0  |
| 1st 13       " | - | -    | 8 15  |
| 2nd 13       " | - | -    | 6 30  |
| 3rd 13       " | - | -    | 8 45  |
| Total          | - | -    | 59 0  |

28 hits on the target.

*June 1, 1864.*

100 rounds were fired by men of the Royal Artillery at targets placed at various distances. The detachments were changed every 20 rounds.

First two shots trial.

The times were as follows:—

|            |   | Min. | Sec. |
|------------|---|------|------|
| 18 rounds  | - | -    | 6 55 |
| 20       " | - | -    | 7 51 |
| 20       " | - | -    | 6 54 |
| 20       " | - | -    | 5 52 |
| 20       " | - | -    | 5 52 |
| Total      |   | 33   | 24   |

Trifling delay during the 18 rounds, caused by the priming wire sticking in the vent.

## WITHOUT LUBRICATORS.

*November 10.*

20 rounds solid shot were fired without lubricators.

Time—12½ minutes.

The practice was excellent.

66 rounds were then fired as rapidly as possible.

Time—22 minutes.

The detachments were changed so that each detach-

ment worked each gun, and at the conclusion of the practice Nos. 1, 2, 3, were asked their opinion as to ease of working.

No. 1 preferred Whitworth as easier to lay.

2       "       M.L. Armstrong as easier to load.

3       "       Whitworth but could give no reason.

All agreed that the muzzle loaders were far preferable to the breech-loader.

## MR. WHITWORTH'S PROGRAMME.

October 12, 1864.

RIFLED SPHERES.

Weight, 3 lbs.  $6\frac{1}{2}$  ozs.Charge,  $1\frac{1}{2}$  lbs.

Single spheres, 1st target 6 inches } deal.\*  
 " 2nd " 4 " }  
 " 3rd " 6 " }  
 10 yards interval.

RANGE, 500 yards.

1st round 45 inches from centre.

|      |   |                 |   |   |
|------|---|-----------------|---|---|
| 2nd  | " | 16              | " | " |
| 3rd  | " | 28              | " | " |
| 4th  | " | $41\frac{1}{2}$ | " | " |
| 5th  | " | 39              | " | " |
| 6th  | " | 10              | " | " |
| 7th  | " | 24              | " | " |
| 8th  | " | 45              | " | " |
| 9th  | " | 19              | " | " |
| 10th | " | 30              | " | " |
| 11th | " | 34              | " | " |
| 12th | " | 20              | " | " |
| 13th | " | 31              | " | " |
| 14th | " | 41              | " | " |
| 15th | " | 23              | " | " |
| 16th | " | 12              | " | " |
| 17th | " | 30              | " | " |
| 18th | " | 23              | " | " |
| 19th | " | 21              | " | " |
| 20th | " | 14              | " | " |

October 14, 1864.

RANGE, 1,000 yards; target, 9 × 9 feet.

Single rifled sphere; from 12-pounder gun; charge,  $1\frac{3}{4}$  lbs.

|       |                                  |
|-------|----------------------------------|
| 1st.  | 5 yards short; 3 yards right.    |
| 2nd.  | 94 " 4 " left.                   |
| 3rd.  | 27 " 2 "                         |
| 4th.  | 56 " in line.                    |
| 5th.  | 200 " over 6 " right.            |
| 6th.  | 170 " 3 "                        |
| 7th.  | 100 " line.                      |
| 8th.  | 24 " 3 yards right.              |
| 9th.  | 18 " short; 3 "                  |
| 10th. | 20 inches from centre of target. |
| 11th. | 150 yards over.                  |
| 12th. | 37 inches from centre of target. |
| 13th. | $53\frac{1}{2}$ " "              |
| 14th. | 34 " "                           |
| 15th. | 70 yards over; 2 yards right.    |
| 16th. | 20 inches from centre of target. |
| 17th. | 6 yards over; 2 yards right.     |
| 18th. | 85 " 1 " "                       |
| 19th. | 17 " 3 " left.                   |
| 20th. | 26 " 3 " right.                  |

\* Were placed behind one another.

TWO SPHERES.

|             | Front of Targets.<br>1st Sphere. | 27' × 9' feet.<br>2nd Sphere. |        |       |
|-------------|----------------------------------|-------------------------------|--------|-------|
|             |                                  | From<br>ground.               | Right. | Left. |
| 1st round - | 100 yards short -                | 3 2                           | 3 6    | —     |
| 2nd " -     | Over -                           | 6 8                           | —      | 2 7   |
| 3rd " -     | Over -                           | 8 10                          | 3 6    | —     |
| 4th " -     | Over -                           | 8 11                          | 2 0    | —     |
| 5th " -     | 100 yards short -                | 2 5                           | 1 6    | —     |
| 6th " -     | 80 " -                           | 5 yards short.                |        |       |
| 7th " -     | 5 " -                            | 4 0                           | —      | 1 0   |

Front of targets increased to 36 × 9 feet.

|           |                                         |               |
|-----------|-----------------------------------------|---------------|
| 8th round | 5 yards short -                         | Over.         |
| 9th " -   | 80 " -                                  | 1 yard short. |
| 10th " -  | 1 foot from<br>ground; 6 feet<br>right. | Over.         |

RANGE, 400 yards.

|            |                                             |                                                  |
|------------|---------------------------------------------|--------------------------------------------------|
| 11th round | 3 ft. 3 in. from<br>ground; 4 ft.<br>right. | Over.                                            |
| 12th " -   | 50 yards short -                            | 5 ft. from ground;<br>1 ft. right.               |
| 13th " -   | Over -                                      | Over.                                            |
| 14th " -   | 50 yards short -                            | $5\frac{1}{2}$ ft. from ground,<br>in line.      |
| 15th " -   | 9 ft. from ground;<br>7 in. left.           | Over.                                            |
| 16th " -   | 3 ft. 6 in. from<br>ground; 4 ft.<br>left.  | 7 ft. from ground;<br>11 in. left.               |
| 17th " -   | 50 yards short -                            | 7 ft. from ground;<br>6 in. right.               |
| 18th " -   | 8 ft. from ground;<br>2 ft. left.           | Over.                                            |
| 19th " -   | 50 yards short -                            | 2 ft. from ground;<br>1 ft. right.               |
| 20th " -   | 30 yards short -                            | 3 ft. 2 in. from<br>ground; 2 ft. 6 in.<br>left. |



## MR. WHITWORTH'S PROGRAMME—continued.

October 13, 1864.

Experiments with rifled spheres continued.  
Three spheres, charge  $1\frac{3}{4}$  lbs.

RANGE, 300 yards.

|                                               |                   |
|-----------------------------------------------|-------------------|
| 1st round, 1st sphere, 23 inches from centre. |                   |
| 2nd "                                         | $27\frac{1}{2}$ " |
| 3rd "                                         | $33\frac{1}{2}$ " |
| 2nd round, 1st "                              | 39 "              |
| 2nd "                                         | $41\frac{1}{2}$ " |
| 3rd "                                         | 113 "             |
| 3rd round, 1st "                              | 14 "              |
| 2nd "                                         | 41 "              |
| 3rd "                                         | 94 "              |

Six spheres ; charge, 1 lb. 3 ozs.

|                                                            |                   |
|------------------------------------------------------------|-------------------|
| 1st round, 1st sphere, 7 inches from centre.               |                   |
| 2nd "                                                      | $27\frac{1}{2}$ " |
| 3rd "                                                      | 42 "              |
| 4th "                                                      | 46 "              |
| 5th "                                                      | $44\frac{1}{2}$ " |
| 6th "                                                      | short.            |
| 2nd round, 1st "                                           | 49 "              |
| 2nd "                                                      | 112 "             |
| 3rd "                                                      | 93 "              |
| 4th "                                                      | 100 "             |
| 5th "                                                      | 87 "              |
| 6th "                                                      | over.             |
| 3rd round, 1st sphere, $26\frac{1}{2}$ inches from centre. |                   |
| 2nd "                                                      | 43 "              |
| 3rd "                                                      | 45 "              |
| 4th "                                                      | 43 "              |
| 5th "                                                      | 62 "              |
| 6th "                                                      | 84 "              |

October 14, 1864.

RIFLED SPHERES.

Three spheres, charge  $1\frac{1}{2}$  lbs.RANGE, 500 yards; target  $45 \times 9$  feet.

|     |                                    |
|-----|------------------------------------|
| 1st | 1st sphere, 84 inches from centre. |
| 2nd | " 122 " "                          |
| 3rd | " 129 " "                          |
| 2nd | 1st " 12 " "                       |
| 2nd | 2nd " 36 " "                       |
| 3rd | 3rd " 72 " "                       |
| 3rd | 1st " 16 " "                       |
| 2nd | 2nd " 55 " "                       |
| 3rd | 3rd " not seen.                    |
| 4th | 1st " 26 " "                       |
| 2nd | 2nd " not seen.                    |
| 3rd | 3rd " not seen.                    |

With six spheres.

|     |                                    |
|-----|------------------------------------|
| 1st | 1st sphere, 43 inches from centre. |
| 2nd | " $38\frac{1}{2}$ " "              |
| 3rd | " 64 " "                           |
| 4th | " 85 " "                           |
| 5th | " 77 " "                           |
| 6th | " 94 " "                           |
| 2nd | 1st " 17 " "                       |
| 2nd | 2nd " 112 " "                      |
| 3rd | 3rd " 98 " "                       |
| 4th | " } not seen.                      |
| 5th | " }                                |
| 6th | " }                                |
| 1st | " $24\frac{1}{2}$ " "              |
| 2nd | " 142 " "                          |
| 3rd | " }                                |
| 4th | " } not seen.                      |
| 5th | " }                                |
| 6th | " }                                |

November 23, 1864.

Shot and hollow shot supplied by Mr. Whitworth  
as the best form for flight fired at  $33^\circ$  elevation.

Gun, 12-pounder Whitworth, 2 lb. charge.

1st five rounds, hollow shot.

|                 |                                                                                                                  |
|-----------------|------------------------------------------------------------------------------------------------------------------|
| 1.—7,855 yards  | - 104 left.                                                                                                      |
| 2.—7,890 "      | - 114 "                                                                                                          |
| 3.—7,610 "      | - 92 "                                                                                                           |
| 4.—6,894 "      | - 38 "                                                                                                           |
| 5.—7,648 "      | - 32 "                                                                                                           |
| 6.—             | These fell about 8,600 yards, but could not<br>be measured accurately as the tide came<br>in.—November 24, 1864. |
| 7.—             |                                                                                                                  |
| 8.—             |                                                                                                                  |
| 9.—             | Not seen.                                                                                                        |
| 10.—8,530 yards | - 75 yards right.                                                                                                |
| 11.—7,582 "     | - 86 " $1\frac{3}{4}$ lb. charge.                                                                                |
| 12.—7,510 "     | - 84 "                                                                                                           |
| 13.—7,618 "     | - 94 "                                                                                                           |
| 14.—7,574 "     | - 89 "                                                                                                           |
| 15.—7,392 "     | - 98 "                                                                                                           |
| 16.—7,394 "     | - 81 " $1\frac{1}{2}$ lb. charge.                                                                                |
| 17.—7,062 "     | - 66 "                                                                                                           |
| 18.—7,156 "     | - 73 "                                                                                                           |
| 19.—8,180 "     | - 96 "                                                                                                           |
| 20.—8,178 "     | - 118 "                                                                                                          |

|                              |                        |
|------------------------------|------------------------|
| 1st five rounds, hollow shot | - 2 lb. charge.        |
| 2nd " solid shot             | - 2 lb. "              |
| 3rd " hollow shot            | - $1\frac{3}{4}$ lb. " |
| 4th " "                      | - $1\frac{1}{2}$ lb. " |

November 23, 1864, very slight breeze.

November 24, 1864, very strong breeze down the range.

The gun was laid by Mr. Whitworth's man with a clinometer.

MR. WHITWORTH'S PROGRAMME—*continued.*

## SUBMARINE PRACTICE.

October 12, 1864.

The target consisted of a 3-inch oak target, 9 × 9 feet.

*No. 1 Round.*—Gun 30 yards from target; axis,  $10\frac{1}{2}$  feet above the water;  $10^\circ$  depression; charge,  $1\frac{3}{4}$  lbs.; projectile, flat-fronted shell weight.

Struck the water about 10 yards from the target; hit the target  $3\frac{1}{2}$  feet below the surface of the water, and in line indented the face of the target .5 of an inch.

*No. 2 Round.*—Gun placed the same as No. 1.  $8^\circ$  depression.

Struck the water 5 yards in front of target; penetrated the target 6 inches from the surface of the water.

*No. 3 Round.*—Gun placed 45 yards from the target.  $5\frac{1}{2}^\circ$  depression.

Struck the water 3 yards in front of the target; penetrated the target 8 inches below the surface of the water, and 1 foot to left of line.

*No. 4 Round.*—Gun placed as for No. 3.  $5\frac{1}{2}^\circ$  depression.

Struck the water 3 yards in front of target; penetrated the target 6 inches from the surface and in line; rose 3 yards behind the target, ricocheted once 5 yards in rear.

October 13.

*No. 5 Round.*—Gun placed 90 yards from the target; axis  $12\frac{1}{2}$  feet above the surface of the water.  $4\frac{1}{2}^\circ$  depression.

Struck the water 4 yards in front of target; glanced upwards and passed through the target 3 inches above the water line.

*No. 6 Round.*—Gun placed as in No. 5.  $3^\circ 15''$  depression.

Struck the water 8 yards in front, rose and fell 30 yards in rear.

*No. 7 Round.*—Gun placed as in No. 5.  $3^\circ 14''$  depression.

Struck the water 8 yards in front of target and ricocheted over.

*No. 8 Round.*—Gun placed as in No. 5.  $4^\circ$  depression.

Struck the water 12 yards in front and ricocheted over target.

*No. 9 Round.*—Gun 33 yards from target.  $5\frac{1}{2}^\circ$  depression.

Struck the water 3 yards in front, and penetrated the target 6 inches below the surface.

*No. 10 Round.*—The gun same as last round.  $6^\circ$  depression.

Struck the water 4 yards in front, and penetrated the target 1 foot below the surface.

The following projectiles were found at the following distances from the target:—

|       |   |   |          |
|-------|---|---|----------|
| No. 1 | - | - | 4 yards. |
| „ 2   | - | - | 7 „      |
| „ 3   | - | - | 16 „     |
| „ 4   | - | - | 18 „     |
| „ 5   | - | - | 12 „     |

October 14, 1864.

*No. 1 Round.*—Gun 33 yards from target: height of water 7 feet 9 inches; depression,  $6^\circ 30''$ .

Struck water 8 yards in front of target, and the target 12 inches below the water; made an indent in target.

*No. 2 Round.*—Gun, &c., as in No. 1 round.

Struck water 8 yards in front of target; made an indent in the target.

*No. 3 Round.*—Gun, &c., as in No. 1 round.

Struck water 8 yards in front of target; made an indent in the target.

*No. 4 Round.*—Gun, &c., as in No. 1 round.

Struck water 8 yards in front of target; made an indent on target.

Average depths of indents,  $1\frac{3}{4}$  inches.



## MR. WHITWORTH'S PROGRAMME—continued.

October 10, 1864.

No. 251. 12-pounder.

C. Shell, 3 diameters long, not tooled; weight, filled with sand, 10 lbs. Elevation, 5°.

The gun was laid by Mr. Whitworth's representative with a clinometer. Charge,  $1\frac{3}{4}$  lbs.

| Round. | Range. | Deflection, Right. |
|--------|--------|--------------------|
| 1      | 2,090  | 21·0               |
| 2      | 2,117  | 20·8               |
| 3      | 2,106  | 12·4               |
| 4      | 2,080  | 21·6               |
| 5      | 2,185  | 16·0               |
| 6      | 2,105  | 17·6               |
| 7      | 2,098  | 17·6               |
| 8      | 2,103  | 15·2               |
| 9      | 2,143  | 19·6               |
| 10     | 2,085  | 18·4               |
| 11     | 2,064  | 18·0               |
| 12     | 2,100  | 18·0               |
| 13     | 2,123  | 17·6               |
| 14     | 2,067  | 20·0               |
| 15     | 2,100  | 21·0               |
| 16     | 2,031  | 19·0               |
| 17     | 2,080  | 18·8               |
| 18     | 2,029  | 19·4               |
| 19     | 2,073  | 16·0               |

October 11, 1864.

Common shell, 5 diameters long. Charge, 2 ozs. Elevation, 45°.

| Round. | Range. | Deflection, |       |
|--------|--------|-------------|-------|
|        |        | Right.      | Left. |
| 1      | 633    | 1·0         | —     |
| 2      | 604    | —           | 5·8   |
| 3      | 636    | —           | 4·0   |

This practice was discontinued as the 2 oz. cartridge allowed the shell to pass the vent.

October 12, 1864.

The end of a shot having been placed at the bottom of the bore to prevent the shell passing the vent, the practice was continued.

Elevation, 45°; charge,  $3\frac{1}{2}$  ozs.

| Round. | Range. | Deflection, Right. |
|--------|--------|--------------------|
|        | Yards. | Yards.             |
| 1      | 1,154  | 23·0               |
| 2      | 1,264  | 13·8               |
| 3      | 1,181  | 23·0               |
| 4      | 1,239  | 15·4               |
| 5      | 1,222  | 11·6               |
| 6      | 1,320  | 14·2               |
| 7      | 1,237  | 12·4               |
| 8      | 1,191  | 12·6               |
| 9      | 1,316  | 12·4               |
| 10     | 1,122  | 11·0               |

SEA SERVICE TRIALS.

The gun was mounted on a common boat's carriage in the bows of a 32-ft. pinnace.

INDEPENDENT FIRING.—November 3, 1864.—PORTSMOUTH.

Ten rounds were fired independently with shot, the boat having very slight but rapid rolling, pitching, and yawing motions.

Wind  ; force, 2.

Shot, 12 lbs.  
Charge,  $1\frac{3}{4}$  lbs.  
Distance of target, 1,800 yards.  
Elevation,  $4^{\circ} 0'$ .  
Deflection,  $0^{\circ} 6' L$ .

10 rounds were completed in 12' 0".  
Recoil, 2 ft. 6 in. and a taut breeching.  
Sponging and loading was performed with difficulty, owing to the length of the gun, and the loading numbers were much exposed.  
Total numbers gained in this practice 48

November 8, 1864.

DISSEMBARKING.

The 12-pounder competitive guns were thrown ashore (on Southsea beach) from the boats, and practised without loss of time as naval field pieces, to ascertain their comparative merits under the circumstances.

Gun, field carriage, and limber was thrown overboard, as the boat touched the beach, and roused ashore by the drag ropes. The limber boxes were carried on shore by the limber numbers. When the gun was mounted it was "Rear" limbered up and marched about 10 yards higher up the beach ; then "Action—Rear," "Load" "1° elevation and lay for the horizon," "Fire," "Cease—Firing."

The following several periods of time are recorded against each gun during the evolutions ; the difference between the times connected with the mounting of carriage and limber must be attributed to the crews only ; but those connected with the handling of the guns may fairly be due to their difference in weight and handiness.

|                                                                                                             |  |  |  |  | Whitworth.   |
|-------------------------------------------------------------------------------------------------------------|--|--|--|--|--------------|
| Boats touching beach to the time when guns were overboard                                                   |  |  |  |  | m. s.        |
|                                                                                                             |  |  |  |  | 1 2          |
| Carriage landed                                                                                             |  |  |  |  | 2 25         |
| " mounted                                                                                                   |  |  |  |  | 3 10         |
| Limber landed                                                                                               |  |  |  |  | Not taken.   |
| " mounted                                                                                                   |  |  |  |  | 4 32         |
| Gun mounted                                                                                                 |  |  |  |  | 4 42         |
| " Rear—Limber up "                                                                                          |  |  |  |  | 6 15         |
| " Action—Rear "                                                                                             |  |  |  |  | 7 30         |
| " Load "                                                                                                    |  |  |  |  | * Not taken. |
| " Fire "                                                                                                    |  |  |  |  | 9 24         |
| Very little cleansing was required; the guns were dragged breech foremost through water, sand, and shingle. |  |  |  |  |              |

\* The order "Load" followed immediately "Action—Rear."

ABSTRACT OF ABOVE PRACTICE.

|                                                                                       |              |               |                          |                               |                                                       |
|---------------------------------------------------------------------------------------|--------------|---------------|--------------------------|-------------------------------|-------------------------------------------------------|
| 12-pounder guns in Boats.<br>November 3, 1864.<br>Independent firing,<br>1,800 yards. | Rounds.      | Time.         | Average Time each Round. | Numbers awarded for Accuracy. | Remarks.                                              |
|                                                                                       | 10           | m. s.<br>15 0 | m. s.<br>1 30            | 53                            | Recoil manageable. Sponge being high delayed the gun. |
|                                                                                       | Mounting.    |               | Orders.                  |                               | Remarks.                                              |
|                                                                                       | Carriage.    | Gun.          | Load.                    | Fire.                         |                                                       |
| 12-pounder guns landed on Southsea beach as field pieces.                             | m. s.<br>2 0 | m. s.<br>4 30 | m. s.<br>6 44            | m. s.<br>8 15                 | The sponging was but the ordinary proceeding.         |



# 12-POUNDER MUZZLE-LOADING ARMSTRONG GUN.

## EXPERIMENTS FOR DETERMINING RANGE AND ACCURACY.

N.B.—The figures in *Italics* are the rounds struck out by the competitors as abnormal shots.

### SOLID SHOT.

### SHOEBURYNNESS.

#### Particulars, &c. of Gun, No. 52.

Weight, 8 cwt. 3 qrs. 27 lbs.  
Length, 5 ft. 11 $\frac{1}{4}$  in.  
Diameter of bore, 3 in.  
Length of bore, 5 ft. 7.7 in.  
Grooves { No. 3.  
          { Width, .71 in.  
          { Depth, .09 in.  
Spiral, 1 turn in 38 calibres.  
No lubrication; dry sponge.

#### Particulars, &c. of Shot and Ammunition.

Weight, 11 lbs. 8.8 oz.  
Diameter, 2.96 in.  
Length, 7.628 in.  
Length of cartridge, 7.5 in.  
Diameter of cartridge, 2.9 in.  
Brand of powder, A4.  
Charge, 1 $\frac{3}{4}$  lbs.  
Wad, junk, and stearine used after April 28; wet sponge used for 13 rounds.

| No. of Round. | Elevation. | Range. | Recoil. | 1st Graze. |        | 2nd Graze. |        | 3rd Graze. |        | Remarks.                                         |
|---------------|------------|--------|---------|------------|--------|------------|--------|------------|--------|--------------------------------------------------|
|               |            |        |         | Right.     | Left.  | Range.     | Right. | Range.     | Right. |                                                  |
|               | °          | Yards. | Ft. in. | Yards.     | Yards. | Yards.     | Yards. | Yards.     | Yards. | <i>April 4, 1864.</i>                            |
| 1             | 0          | 509    | 6 3     | —          | 4.0    | 2,522      | 20     | 3,664      | 82     | The gun was placed 15 feet to the left of line.  |
| 2             | "          | 513    | 6 6     | —          | 3.4    | 2,015      | 24     | Not seen.  |        |                                                  |
| 3             | "          | 536    | 6 6     | —          | 3.2    | 2,125      | 26.2   | 3,400      | 68     |                                                  |
| 4             | "          | 1,358  | 6 3     | 3.2        | —      | 2,618      | 34.6   | 4,350      | 115*   | Weather:—Hazy at 10 a.m.                         |
| 5             | "          | 511    | 6 4     | —          | 4.2    | 2,158      | 42.4   | 2,900      | 116    | Slight haze at 3 p.m.                            |
| 6             | "          | 524    | 6 4     | —          | 3.8    | 2,194      | 40.6   | 3,135      | 62     | Wind:—Direction, S.E. by E. ; force, 1 ; 10 a.m. |
| 7             | "          | 522    | —       | —          | 3.8    | 1,932      | 41.6   | 3,150      | 26     | " N.N.W. ; force, 1 ; 10 a.m.                    |
| 8             | 1          | 900    | 6 4     | —          | 1.6    | 2,242      | 66.6   | 3,706      | 220    | " 3 p.m.                                         |
| 9             | "          | 914    | 6 4     | —          | 1.6    | 2,640      | 39.6   | 3,723      | 189    | Thermometer :—48 dry, 47 wet, 10 a.m.            |
| 10            | "          | 920    | 6 7     | —          | 2.0    | 2,561      | 55.6   | 3,643      | 423    | 60 " 58 " 3 p.m.                                 |
| 11            | "          | 885    | 6 7     | —          | 4.0    | 2,656      | 6.6    | 3,606      | 244    | Reading. Temperature.                            |
| 12            | "          | 889    | 5 9     | —          | 3.0    | 2,264      | 66.    | 3,418      | 17     | Barometer :—29.75 50 10 a.m.                     |
| 13            | "          | 902    | —       | —          | 0.8    | 2,604      | 38.6   | 3,755      | 89     | 29.95 62 3 p.m.                                  |

\* By order of Committee.

| No. of Round. | Elevation. | Range. | 1st Graze. |        |        | 2nd Graze. |        | Remarks.                                                                    |
|---------------|------------|--------|------------|--------|--------|------------|--------|-----------------------------------------------------------------------------|
|               |            |        | In Line.   | Right. | Left.  | Range.     | Right. |                                                                             |
|               | °          | Yards. |            | Yards. | Yards. | Yards.     | Yards. | <i>May 13, 1864.</i>                                                        |
| 1             | 0          | 472    | —          | 1.0    | —      | —          | —      | The gun was in line.                                                        |
| 2             | "          | 489    | —          | 0.8    | —      | —          | —      |                                                                             |
| 3             | "          | 542    | —          | 0.4    | —      | —          | —      |                                                                             |
| 4             | "          | 486    | —          | 0.4    | —      | —          | —      | Weather:—Very slight haze, 10 a.m.<br>Haze on water, 3 p.m.                 |
| 5             | "          | 480    | —          | 0.8    | —      | —          | —      |                                                                             |
| 6             | "          | 527    | —          | 0.2    | —      | —          | —      |                                                                             |
| 7             | "          | 544    | —          | —      | 0.8    | —          | —      | Wind:—Direction, N.E. by N.; force, 2; 10 a.m.<br>" S.E. by S. " 2; 3 p.m.  |
| 8             | "          | 546    | Yes.       | —      | —      | —          | —      |                                                                             |
| 9             | "          | 501    | —          | 0.6    | —      | —          | —      |                                                                             |
| 10            | "          | 504    | —          | 1.2    | —      | —          | —      | Thermometer:—61 dry, 58 wet, 10 a.m.<br>62 " 58 " 3 p.m.                    |
| 11            | "          | 487    | —          | 0.2    | —      | —          | —      |                                                                             |
| 12            | "          | 533    | —          | 0.6    | —      | —          | —      |                                                                             |
| 13            | "          | 517    | —          | 0.4    | —      | —          | —      | Reading. Temperature.<br>Barometer:—30.05 58 10 a.m.<br>30.10 61 3 p.m.     |
| 14            | "          | 531    | Yes.       | —      | —      | —          | —      |                                                                             |
| 15            | "          | 534    | Yes.       | —      | —      | —          | —      |                                                                             |
| 16            | "          | 508    | Yes.       | —      | —      | —          | —      | The gun was 15 feet left of line.                                           |
| 17            | "          | 494    | —          | 0.8    | —      | —          | —      |                                                                             |
| 18            | "          | 532    | Yes.       | —      | —      | —          | —      |                                                                             |
| 19            | "          | 538    | —          | —      | 0.2    | —          | —      | Weather:—Clear.                                                             |
| 20            | "          | 509    | —          | 0.4    | —      | —          | —      |                                                                             |
| 1             | 1          | 964    | —          | —      | 3.6    | 2,510      | 60     | Wind:—Direction, N.E. by N.; force, 4; 10 a.m.<br>" S.E. by E.; " 3; 3 p.m. |
| 2             | "          | 892    | —          | —      | 1.6    | 2,490      | 26     |                                                                             |
| 3             | "          | 936    | —          | —      | 3.4    | 2,612      | 52     |                                                                             |
| 4             | "          | 938    | —          | —      | 3.4    | 2,512      | 58     | Thermometer:—44 dry, 41 wet, 10 a.m.<br>45 " 42 " 3 p.m.                    |
| 5             | "          | 943    | —          | —      | 3.4    | 2,534      | 60     |                                                                             |
| 6             | "          | 917    | —          | —      | 3.8    | 2,471      | 45     |                                                                             |
| 7             | "          | 942    | —          | —      | 3.2    | 2,500      | 34     | Reading. Temperature.<br>Barometer:—30.25 52 10 a.m.<br>30.30 60 3 p.m.     |
| 8             | "          | 915    | —          | —      | 3.4    | 2,478      | 53     |                                                                             |
| 9             | "          | 939    | —          | —      | 3.8    | 2,598      | 59     |                                                                             |
| 10            | "          | 937    | —          | —      | 3.8    | 2,566      | 18     | By order of Committee.                                                      |
| 11            | "          | 933    | —          | —      | 3.6    | 2,400      | 31     |                                                                             |
| 12            | "          | 943    | —          | —      | 3.4    | 2,452      | 30     |                                                                             |
| 13            | "          | 912    | —          | —      | 3.6    | 2,489      | 38     |                                                                             |
| 14            | "          | 915    | —          | —      | 3.6    | 2,626      | 58     |                                                                             |
| 15            | 2          | 1,260  | —          | 0.2    | —      | 2,852      | 90     |                                                                             |

RANGE AND ACCURACY.—SOLID SHOT—*continued.*

| No. of Round.          | Elevation. | Range. | 1st Graze. |        |        | 2nd Graze. |        | Remarks.                                                                     |
|------------------------|------------|--------|------------|--------|--------|------------|--------|------------------------------------------------------------------------------|
|                        |            |        | In Line.   | Right. | Left.  | Range.     | Right. |                                                                              |
|                        | °          | Yards. |            | Yards. | Yards. | Yards.     | Yards. |                                                                              |
| 1                      | 2          | 1,264  | —          | —      | 2      | 2,992      | 46     | <i>April 11, 1864</i>                                                        |
| 2                      | "          | 1,252  | —          | —      | 4.2    | 2,893      | 70     |                                                                              |
| 3                      | "          | 1,272  | —          | —      | 3.2    | 3,058      | 57     |                                                                              |
| 4                      | "          | 1,280  | —          | —      | 4.0    | 2,858      | 40     |                                                                              |
| 5                      | "          | 1,269  | —          | —      | 2.8    | 2,907      | 49     | The gun was 15 feet left of line.                                            |
| 6                      | "          | 1,281  | —          | —      | 4.0    | 3,220      | 31     | Weather :—Very thick haze.                                                   |
| 7                      | "          | 1,278  | —          | —      | 3.4    | 2,819      | 52     |                                                                              |
| 8                      | "          | 1,240  | —          | —      | 2.4    | 3,350      | 77     | Wind :—Direction, W.N.W. ; force, nil ; 10 a.m.                              |
| 9                      | "          | 1,250  | —          | —      | 2.8    | 2,893      | 80     | " " W.S.W. ; " " 1 ; 3 p.m.                                                  |
| 10                     | "          | 1,162  | —          | —      | 3.8    | 2,556      | 72     | Thermometer :—47 dry, 45 wet, 10 a.m.                                        |
| 11                     | "          | 1,267  | —          | —      | 4.0    | 2,954      | 58     | 50 " 51 " 3 p.m.                                                             |
| 12                     | "          | 1,262  | —          | —      | 2.0    | 2,994      | 44     |                                                                              |
| 13                     | "          | 1,292  | —          | —      | 4.4    | 3,194      | 23     |                                                                              |
| 14                     | "          | 1,229  | —          | —      | 5.0    | 2,711      | 50     | Barometer :—<br>Reading. Temperature.<br>30.10 52 10 a.m.<br>30.05 54 3 p.m. |
| 15                     | "          | 1,239  | —          | 7.4    | —      | 2,885      | 15     |                                                                              |
| 16                     | "          | 1,267  | —          | —      | 4.4    | 3,008      | 36     |                                                                              |
| 17                     | "          | 1,266  | —          | —      | 4.2    | 2,942      | 45     |                                                                              |
| 18                     | "          | 1,255  | —          | —      | 4.6    | 3,000      | 23     |                                                                              |
| 19                     | "          | 1,265  | —          | —      | 4.6    | 2,794      | 51     |                                                                              |
| 20                     | "          | 1,286  | —          | —      | 4.0    | 3,088      | 45     |                                                                              |
| <i>April 13, 1864.</i> |            |        |            |        |        |            |        |                                                                              |
| 1                      | 3          | 1,600  | —          | 3.4    | —      | —          | —      |                                                                              |
| 2                      | "          | 1,596  | —          | 9.2    | —      | —          | —      |                                                                              |
| 3                      | "          | 1,564  | —          | 7.8    | —      | —          | —      |                                                                              |
| 4                      | "          | 1,585  | —          | 7.2    | —      | —          | —      |                                                                              |
| 5                      | "          | 1,568  | —          | 3.4    | —      | —          | —      | The gun was 15 feet to the right.                                            |
| 6                      | "          | 1,608  | —          | 8.0    | —      | —          | —      | Weather :—Slight haze on water, 10 a.m.                                      |
| 7                      | "          | 1,616  | —          | 9.4    | —      | —          | —      | Clear, 3 p.m.                                                                |
| 8                      | "          | 1,601  | —          | 9.6    | —      | —          | —      | Wind :—Direction, S.E. by S. ; force, 5 ; 10 a.m.                            |
| 9                      | "          | 1,606  | —          | 9.8    | —      | —          | —      | " " E. " " 5 ; 3 p.m.                                                        |
| 10                     | "          | 1,550  | —          | 7.8    | —      | —          | —      | Thermometer :—48 dry, 46 wet, 10 a.m.                                        |
| 11                     | "          | 1,593  | —          | 7.6    | —      | —          | —      | 50 " 46 " 3 p.m.                                                             |
| 12                     | "          | 1,440  | —          | 6.4    | —      | —          | —      |                                                                              |
| 13                     | "          | 1,609  | —          | 6.0    | —      | —          | —      |                                                                              |
| 14                     | "          | 1,614  | —          | 6.4    | —      | —          | —      |                                                                              |
| 15                     | "          | 1,618  | —          | 9.4    | —      | —          | —      | Barometer :—<br>Reading. Temperature.<br>30.15 52 10 a.m.<br>30.10 54 3 p.m. |
| 16                     | "          | 1,601  | —          | 11.4   | —      | —          | —      |                                                                              |
| 17                     | "          | 1,586  | —          | 6.4    | —      | —          | —      |                                                                              |
| 18                     | "          | 1,610  | —          | 8.4    | —      | —          | —      |                                                                              |
| 19                     | "          | 1,610  | —          | 10.4   | —      | —          | —      |                                                                              |
| 20                     | "          | 1,595  | —          | 8.6    | —      | —          | —      |                                                                              |
| <i>April 14, 1864.</i> |            |        |            |        |        |            |        |                                                                              |
| 1                      | 4          | 1,939  | —          | 4.0    | —      | —          | —      |                                                                              |
| 2                      | "          | 1,930  | —          | 7.0    | —      | —          | —      |                                                                              |
| 3                      | "          | 1,943  | —          | 5.6    | —      | —          | —      |                                                                              |
| 4                      | "          | 1,933  | —          | 6.8    | —      | —          | —      |                                                                              |
| 5                      | "          | 1,847  | —          | 5.0    | —      | —          | —      | The gun was on the line.                                                     |
| 6                      | "          | 1,908  | —          | 6.2    | —      | —          | —      | Weather :—Very slight haze on water, 10 a.m.                                 |
| 7                      | "          | 1,945  | —          | 7.0    | —      | —          | —      | Clear at 3 p.m.                                                              |
| 8                      | "          | 1,940  | —          | 5.2    | —      | —          | —      | Wind :—Direction, E. ; force, 4 ; 10 a.m.                                    |
| 9                      | "          | 1,951  | —          | 5.8    | —      | —          | —      | " " " " 6 ; 3 p.m.                                                           |
| 10                     | "          | 1,932  | —          | 7.4    | —      | —          | —      | Thermometer :—44 dry, 41 wet, 10 a.m.                                        |
| 11                     | "          | 1,895  | —          | 7.6    | —      | —          | —      | 50 " 47 " 3 p.m.                                                             |
| 12                     | "          | 1,884  | —          | 7.0    | —      | —          | —      |                                                                              |
| 13                     | "          | 1,918  | —          | 8.0    | —      | —          | —      |                                                                              |
| 14                     | "          | 1,899  | —          | 6.0    | —      | —          | —      |                                                                              |
| 15                     | "          | 1,943  | —          | 6.4    | —      | —          | —      | Barometer :—<br>Reading. Temperature.<br>30.00 51 10 a.m.<br>30.05 59 3 p.m. |
| 16                     | "          | 1,925  | —          | 6.6    | —      | —          | —      |                                                                              |
| 17                     | "          | 1,932  | —          | 6.0    | —      | —          | —      |                                                                              |
| 18                     | "          | 1,908  | —          | 5.0    | —      | —          | —      |                                                                              |
| 19                     | "          | 1,911  | —          | 6.0    | —      | —          | —      |                                                                              |
| 20                     | "          | 1,918  | —          | 5.0    | —      | —          | —      |                                                                              |



RANGE AND ACCURACY.—SOLID SHOT—*continued.*

| No. of Round.   | Elevation.   | Range. | 1st Graze. |        |        | 2nd Graze. |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|-----------------|--------------|--------|------------|--------|--------|------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|                 |              |        | In Line.   | Right. | Left.  | Range.     | Right. |                                                                                                                                                         |          |              |       |    |       |    |
|                 | °            | Yards. |            | Yards. | Yards. | Yards.     | Yards. |                                                                                                                                                         |          |              |       |    |       |    |
| 1               | 5            | 2,209  | —          | —      | 0·6    | —          | —      | April 15, 1864.                                                                                                                                         |          |              |       |    |       |    |
| 2               | "            | 2,244  | —          | 4·0    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3               | "            | 2,230  | —          | 1·2    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 4               | "            | 2,260  | Yes.       | —      | —      | —          | —      | The gun was 15 feet to left of line.                                                                                                                    |          |              |       |    |       |    |
| 5               | "            | 2,230  | —          | 1·0    | —      | —          | —      | Weather :—Hazy.                                                                                                                                         |          |              |       |    |       |    |
| 6               | "            | 2,243  | —          | 1·4    | —      | —          | —      | Wind :—Direction S.E. by S. ; force, 3 ; 10 a.m.                                                                                                        |          |              |       |    |       |    |
| 7               | "            | 2,170  | —          | 0·6    | —      | —          | —      | " " " 4 ; 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 8               | "            | 2,210  | —          | 4·4    | —      | —          | —      | Thermometer :—51 dry, 48 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 9               | "            | 2,260  | —          | 3·6    | —      | —          | —      | 55 52 " 3 p.m.                                                                                                                                          |          |              |       |    |       |    |
| 10              | "            | 2,206  | —          | 6·4    | —      | —          | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29·75</td><td>52</td></tr><tr><td>29·75</td><td>56</td></tr></table> 10 a.m. | Reading. | Temperature. | 29·75 | 52 | 29·75 | 56 |
| Reading.        | Temperature. |        |            |        |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·75           | 52           |        |            |        |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·75           | 56           |        |            |        |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 11              | "            | 2,160  | —          | —      | 4·4    | —          | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 12              | "            | 2,220  | —          | 1·4    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 13              | "            | 2,186  | —          | —      | 0·4    | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 14              | "            | 2,214  | —          | 2·4    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 15              | "            | 2,223  | —          | 1·2    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 16              | "            | 2,200  | —          | 4·4    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 17              | "            | 2,249  | —          | 4·4    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 18              | "            | 2,256  | —          | 3·4    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 19              | "            | 2,270  | —          | 4·6    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 20              | "            | 2,266  | —          | 2·0    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| April 15, 1864. |              |        |            |        |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 1               | 6            | 2,602  | —          | 6·0    | —      | —          | —      | The gun was 15 feet to left of line.                                                                                                                    |          |              |       |    |       |    |
| 2               | "            | 2,544  | —          | 5·4    | —      | —          | —      | Weather :—Hazy.                                                                                                                                         |          |              |       |    |       |    |
| 3               | "            | 2,602  | —          | 6·4    | —      | —          | —      | Wind :—Direction, S.E. by S. ; force, 3 ; 10 a.m.                                                                                                       |          |              |       |    |       |    |
| 4               | "            | 2,564  | —          | 7·6    | —      | —          | —      | " " " 4 ; 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 5               | "            | 2,555  | —          | 7·8    | —      | —          | —      | Thermometer :—51 dry, 48 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 6               | "            | 2,581  | —          | 4·4    | —      | —          | —      | 55 " 52 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 7               | "            | 2,584  | —          | 7·0    | —      | —          | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29·75</td><td>52</td></tr><tr><td>29·75</td><td>56</td></tr></table> 10 a.m. | Reading. | Temperature. | 29·75 | 52 | 29·75 | 56 |
| Reading.        | Temperature. |        |            |        |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·75           | 52           |        |            |        |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·75           | 56           |        |            |        |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 8               | "            | 2,440  | —          | 8·4    | —      | —          | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 9               | "            | 2,560  | —          | 6·4    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 10              | "            | 2,546  | —          | 4·4    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 11              | "            | 2,544  | —          | 8·4    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 12              | "            | 2,590  | —          | 9·0    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 13              | "            | 2,488  | —          | 9·0    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 14              | "            | 2,594  | —          | 8·4    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 15              | "            | 2,580  | —          | 9·0    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 16              | "            | 2,543  | —          | 12·2   | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 17              | "            | 2,542  | —          | 9·4    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 18              | "            | 2,555  | —          | 10·6   | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 19              | "            | 2,556  | —          | 4·4    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 20              | "            | 2,564  | —          | 7·0    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| April 15, 1864. |              |        |            |        |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 1               | 7            | 2,708  | —          | 14·0   | —      | —          | —      | The gun was 15 feet left of line.                                                                                                                       |          |              |       |    |       |    |
| 2               | "            | 2,834  | —          | 15·2   | —      | —          | —      | Weather :—Hazy.                                                                                                                                         |          |              |       |    |       |    |
| 3               | "            | 2,840  | —          | 14·8   | —      | —          | —      | Wind :—Direction, S.E. by S. ; force, 3 ; 10 a.m.                                                                                                       |          |              |       |    |       |    |
| 4               | "            | 2,844  | —          | 13·4   | —      | —          | —      | " " " 4 ; 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 5               | "            | 2,866  | —          | 11·4   | —      | —          | —      | Thermometer :—51 dry, 48 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 6               | "            | 2,876  | —          | 15·4   | —      | —          | —      | 55 52 " 3 p.m.                                                                                                                                          |          |              |       |    |       |    |
| 7               | "            | 2,843  | —          | 12·0   | —      | —          | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29·75</td><td>52</td></tr><tr><td>29·75</td><td>56</td></tr></table> 10 a.m. | Reading. | Temperature. | 29·75 | 52 | 29·75 | 56 |
| Reading.        | Temperature. |        |            |        |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·75           | 52           |        |            |        |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·75           | 56           |        |            |        |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 8               | "            | 2,880  | —          | 11·6   | —      | —          | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 9               | "            | 2,890  | —          | 14·4   | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 10              | "            | 2,860  | —          | 9·6    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 11              | "            | 2,846  | —          | 13·2   | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 12              | "            | 2,870  | —          | 11·2   | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 13              | "            | 2,860  | —          | 7·2    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 14              | "            | 2,845  | —          | 10·4   | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 15              | "            | 2,849  | —          | 12·0   | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 16              | "            | 2,866  | —          | 14·6   | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 17              | "            | 2,814  | —          | 4·4    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 18              | "            | 2,994  | —          | 6·8    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 19              | "            | 2,811  | —          | 6·2    | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 20              | "            | 2,890  | —          | 12·4   | —      | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |

RANGE AND ACCURACY.—SOLID SHOT—*continued.*

| No. of Round. | Elevation. | Range. | 1st Graze. |        |        | 2nd Graze. |        | Remarks.                                          |
|---------------|------------|--------|------------|--------|--------|------------|--------|---------------------------------------------------|
|               |            |        | In Line.   | Right. | Left.  | Range.     | Right. |                                                   |
|               | °          | Yards. |            | Yards. | Yards. | Yards.     | Yards. |                                                   |
| 1             | 8          | 2,986  | —          | 48·6   | —      | —          | —      | <i>April 25, 1864.</i>                            |
| 2             | "          | 3,108  | —          | 37·2   | —      | —          | —      |                                                   |
| 3             | "          | 3,150  | —          | 35·0   | —      | —          | —      |                                                   |
| 4             | "          | 3,107  | —          | 38·0   | —      | —          | —      | The gun was 15 feet right of line.                |
| 5             | "          | 3,095  | —          | 32·4   | —      | —          | —      | Weather :—Clear at 10 a.m.                        |
| 6             | "          | 3,103  | —          | 36·6   | —      | —          | —      | do. 3 p.m.                                        |
| 7             | "          | 3,108  | —          | 38·2   | —      | —          | —      |                                                   |
| 8             | "          | 3,124  | —          | 31·6   | —      | —          | —      | Wind :—Direction, E. ; force, 4 ; 10 a.m.         |
| 9             | "          | 3,102  | —          | 31·0   | —      | —          | —      | " E.S.E. " 3 ; 3 p.m.                             |
| 10            | "          | 3,098  | —          | 33·4   | —      | —          | —      |                                                   |
| 11            | "          | 3,095  | —          | 34·4   | —      | —          | —      | Thermometer :—51 dry, 48 wet, 10 a.m.             |
| 12            | "          | 3,088  | —          | 31·4   | —      | —          | —      | 52 " 50 " 3 p.m.                                  |
| 13            | "          | 3,032  | —          | 31·6   | —      | —          | —      |                                                   |
| 14            | "          | 3,146  | —          | 34·6   | —      | —          | —      | Reading. Temperature.                             |
| 15            | "          | 3,084  | —          | 31·4   | —      | —          | —      | Barometer :—30·20 52 10 a.m.                      |
| 16            | "          | 3,075  | —          | 32·6   | —      | —          | —      | 30·15 55 3 p.m.                                   |
| 17            | "          | 3,136  | —          | 37·0   | —      | —          | —      |                                                   |
| 18            | "          | 3,049  | —          | 31·4   | —      | —          | —      |                                                   |
| 19            | "          | 3,092  | —          | 33·0   | —      | —          | —      |                                                   |
| 20            | "          | 3,096  | —          | 27·0   | —      | —          | —      |                                                   |
|               |            |        |            |        |        |            |        | <i>April 26, 1864.</i>                            |
| 1             | 9          | 3,262  | —          | 12·4   | —      | —          | —      |                                                   |
| 2             | "          | 3,270  | —          | 20·8   | —      | —          | —      |                                                   |
| 3             | "          | 3,340  | —          | 16·4   | —      | —          | —      |                                                   |
| 4             | "          | 3,312  | —          | 16·6   | —      | —          | —      | The gun was 15 feet right of line.                |
| 5             | "          | 3,343  | —          | 14·6   | —      | —          | —      | Weather :—Hazy at 10 a.m.                         |
| 6             | "          | 3,322  | —          | 13·2   | —      | —          | —      | Clear at 3 p.m.                                   |
| 7             | "          | 3,360  | —          | 12·8   | —      | —          | —      |                                                   |
| 8             | "          | 3,336  | —          | 13·4   | —      | —          | —      | Wind :—Direction, N.E. by E. ; force, 1 ; 10 a.m. |
| 9             | "          | 3,312  | —          | 18·4   | —      | —          | —      | " E. by S. ; " 2 ; 3 p.m.                         |
| 10            | "          | 3,336  | —          | 18·0   | —      | —          | —      |                                                   |
| 11            | "          | 3,330  | —          | 14·6   | —      | —          | —      | Thermometer :—52 dry, 49 wet, 10 a.m.             |
| 12            | "          | 3,286  | —          | 18·4   | —      | —          | —      | 52 " 49 " 3 p.m.                                  |
| 13            | "          | 3,365  | —          | 9·8    | —      | —          | —      |                                                   |
| 14            | "          | 3,319  | —          | 18·4   | —      | —          | —      | Reading. Temperature.                             |
| 15            | "          | 3,315  | —          | 14·2   | —      | —          | —      | Barometer :—30·20 52 10 a.m.                      |
| 16            | "          | 3,406  | —          | 14·4   | —      | —          | —      | 30·35 53 3 p.m.                                   |
| 17            | "          | 3,278  | —          | 10·2   | —      | —          | —      |                                                   |
| 18            | "          | 3,297  | —          | 16·0   | —      | —          | —      |                                                   |
| 19            | "          | 3,374  | —          | 12·2   | —      | —          | —      |                                                   |
| 20            | "          | 3,420  | —          | 9·0    | —      | —          | —      |                                                   |
|               |            |        |            |        |        |            |        | <i>April 27, 1864.</i>                            |
| 1             | 10         | 3,532  | —          | 51·4   | —      | —          | —      |                                                   |
| 2             | "          | 3,414  | —          | 50·4   | —      | —          | —      |                                                   |
| 3             | "          | 3,609  | —          | 49·0   | —      | —          | —      |                                                   |
| 4             | "          | 3,559  | —          | 55·0   | —      | —          | —      |                                                   |
| 5             | "          | 3,542  | —          | 56·0   | —      | —          | —      | The gun was 15 feet right of line.                |
| 6             | "          | 3,460  | —          | 37·6   | —      | —          | —      | Weather :—Hazy, 10 a.m.                           |
| 7             | "          | 3,358  | —          | 48·0   | —      | —          | —      | Slight haze, 3 p.m.                               |
| 8             | "          | 3,491  | —          | 50·0   | —      | —          | —      |                                                   |
| 9             | "          | 3,569  | —          | 49·6   | —      | —          | —      | Wind :—Direction, E. ; force, 3 ; 10 a.m.         |
| 10            | "          | 3,557  | —          | 48·6   | —      | —          | —      | " E.S.E. ; " 4 ; 3 p.m.                           |
| 11            | "          | 3,507  | —          | 46·6   | —      | —          | —      |                                                   |
| 12            | "          | 3,544  | —          | 50·6   | —      | —          | —      | Thermometer :—49 dry, 47 wet, 10 a.m.             |
| 13            | "          | 3,512  | —          | 42·0   | —      | —          | —      | 50 " 48 " 3 p.m.                                  |
| 14            | "          | 3,520  | —          | 43·0   | —      | —          | —      |                                                   |
| 15            | "          | 3,503  | —          | 44·0   | —      | —          | —      | Reading. Temperature.                             |
| 16            | "          | 3,507  | —          | 44·6   | —      | —          | —      | Barometer :—30·20 51 10 a.m.                      |
| 17            | "          | 3,703  | —          | 46·6   | —      | —          | —      | 30·20 53 3 p.m.                                   |
| 18            | "          | 3,508  | —          | 49·4   | —      | —          | —      |                                                   |
| 19            | "          | 3,545  | —          | 54·4   | —      | —          | —      |                                                   |
| 20            | "          | 3,553  | —          | 52·4   | —      | —          | —      |                                                   |



RANGE AND ACCURACY.—SOLID SHOT—*continued.*

| No. of Round. | Elevation. | Range. | 1st Graze. |        | Remarks.                                          |
|---------------|------------|--------|------------|--------|---------------------------------------------------|
|               |            |        |            | Right. |                                                   |
|               | °          | Yards. | Yards.     |        | June 16, 1864.                                    |
| 1             | 15         | 4,655  | 68         |        | No. 2 gun, 9 feet left of line.                   |
| 2             | "          | 4,765  | 62         |        | Weather :—Hazy and rain, 10 a.m.                  |
| 3             | "          | 4,780  | 74         |        | Cloudy, 3 p.m.                                    |
| 4             | "          | 4,743  | 67         |        | Wind :—Direction, N.W. by W. ; force, 4 ; 10 a.m. |
| 5             | "          | 4,747  | 76         |        | " N.W. " 3 ; 3 p.m.                               |
| 6             | "          | 4,748  | 72         |        | Thermometer :—69 dry, 66 wet, 10 a.m.             |
| 7             | "          | 4,604  | 84         |        | 70 " 69 " 3 p.m.                                  |
| 8             | "          | 4,584  | 58         |        |                                                   |
| 9             | "          | 4,697  | 62         |        | Reading. Temperature.                             |
| 10            | "          | 4,736  | 74         |        | Barometer :—29·90 63 10 a.m.                      |
|               |            |        |            |        | 30·00 64 3 p.m.                                   |
|               |            |        |            |        | June 27, 1864.                                    |
| 1             | 25         | 5,880  | 234        |        | No. 2 gun, 9 feet left of line.                   |
| 2             | "          | 5,974  | 208        |        | Weather :—Cloudy, 10 a.m.                         |
| 3             | "          | 5,935  | 202        |        | " 3 p.m.                                          |
| 4             | "          | 6,086  | 214        |        | Wind :—Direction, N.N.W. ; force, 4 ; 10 a.m.     |
| 5             | "          | 5,980  | 206        |        | " " 3 ; 3 p.m.                                    |
| 6             | "          | 5,967  | 219        |        | Thermometer :—61 dry, 55 wet, 10 a.m.             |
| 7             | "          | 5,926  | 198        |        | 61 " 57 " 3 p.m.                                  |
| 8             | "          | 6,082  | 186        |        |                                                   |
| 9             | "          | 5,996  | 205        |        | Reading. Temperature.                             |
| 10            | "          | 5,828  | 190        |        | Barometer :—30·10 59 10 a.m.                      |
|               |            |        |            |        | 30·15 59 3 p.m.                                   |
|               |            |        |            |        | June 28, 1864.                                    |
| 1             | 33         | 6,618  | 182        |        | No. 2 gun, 9 feet left of line.                   |
| 2             | "          | 6,724  | 197        |        | Weather :—Thick haze on water, 10 a.m.            |
| 3             | "          | 6,630  | 220        |        | Very thick haze and slight rain, 3 p.m.           |
| 4             | "          | 6,740  | 176        |        | Wind :—Direction, N.W. by W. ; force, 4 ; 10 a.m. |
| 5             | "          | 6,882  | 206        |        | " S.W. by W. ; " 3 ; 3 p.m.                       |
| 6             | "          | 6,932  | 158        |        | Thermometer :—61 dry, 58 wet, 10 a.m.             |
| 7             | "          | 6,754  | 127        |        | 64 " 61 " 3 p.m.                                  |
| 8             | "          | 6,740  | 134        |        |                                                   |
| 9             | "          | 6,752  | 140        |        | Reading. Temperature.                             |
| 10            | "          | 6,816  | 192        |        | Barometer :—30·18 60 10 a.m.                      |
|               |            |        |            |        | 30·00 62 3 p.m.                                   |

## AFTER FIRING 2,800 ROUNDS.

| No. of Round. | Elevation. | Range. | 1st Graze. |        | Remarks.                                     |
|---------------|------------|--------|------------|--------|----------------------------------------------|
|               |            |        |            | Right. |                                              |
|               | °          | Yards. | Yards.     |        | <i>December 22, 1864.</i>                    |
| 1             | 5          | 1,950  | 2·2        |        |                                              |
| 2             | "          | 1,851  | 7·2        |        |                                              |
| 3             | "          | 1,967  | 6·6        |        |                                              |
| 4             | "          | 1,916  | 4·0        |        |                                              |
| 5             | "          | 1,920  | 8·6        |        |                                              |
| 6             | "          | 1,912  | 2·0        |        |                                              |
| 7             | "          | 1,941  | 3·6        |        | The gun was 5 yards left of line.            |
| 8             | "          | 1,934  | 4·0        |        | Weather :—Clear.                             |
| 9             | "          | 1,914  | 4·8        |        |                                              |
| 10            | "          | 1,946  | 4·2        |        | Wind :—Direction, W. by S; force, 4; 10 a.m. |
| 11            | "          | 1,892  | 4·2        |        | " E. " 7; 3 p.m.                             |
| 12            | "          | 1,916  | 7·8        |        |                                              |
| 13            | "          | 1,896  | 6·0        |        | Thermometer :—37 dry, 36 wet, 10 a.m.        |
| 14            | "          | 1,894  | 1·6        |        | 37 " 36 " 3 p.m.                             |
| 15            | "          | 1,963  | 4·2        |        | Reading. Temperature.                        |
| 16            | "          | 1,918  | 2·6        |        | Barometer :—30·12 41 10 a.m.                 |
| 17            | "          | 1,913  | 4·0        |        | 30·20 41 3 p.m.                              |
| 18            | "          | 1,932  | 1·2        |        |                                              |
| 19            | "          | 1,894  | 6·4        |        |                                              |
| 20            | "          | 1,941  | 2·0        |        |                                              |
| 21            | "          | 1,936  | 8·0        |        |                                              |
| 22            | "          | 1,797  | 7·4        |        |                                              |

RANGE AND ACCURACY—continued.

SHOT.

| No. of Round. | Elevation.   | Range.  | 1st Graze. | Remarks.                                                                                                                                                                                |          |              |  |       |    |         |       |    |        |
|---------------|--------------|---------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|--|-------|----|---------|-------|----|--------|
|               |              |         | Left.      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
|               |              |         |            | March 7, 1865.                                                                                                                                                                          |          |              |  |       |    |         |       |    |        |
|               | °            | Yards.  | Yards.     |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1             | 5            | 2,087   | 10·0       |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 2             | "            | 2,069   | 1·4        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3             | "            | 2,123   | 3·6        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 4             | "            | 2,176   | 4·0        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 5             | "            | 2,191   | 4·4        | Without lubricators.                                                                                                                                                                    |          |              |  |       |    |         |       |    |        |
| 6             | "            | 2,168   | 6·0        | Weather :—Slight haze.                                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 7             | "            | 2,129   | 7·2        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 8             | "            | 2,171   | 5·2        | Wind :—Direction, N.; force, 3; 10 a.m.                                                                                                                                                 |          |              |  |       |    |         |       |    |        |
| 9             | "            | 2,090   | 7·0        | "    N.N.W.; "    3; 3 p.m.                                                                                                                                                             |          |              |  |       |    |         |       |    |        |
| 10            | "            | 2,108   | 4·4        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 11            | "            | 2,137   | 5·6        | Thermometer :—38 dry, 38 wet, 10 a.m.                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 12            | "            | 2,136   | 6·4        | 44 " 42 " 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 13            | "            | 2,150   | 7·0        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 14            | "            | 2,100   | 5·6        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>29·57</td><td>42</td><td>10 a.m.</td></tr><tr><td>29·60</td><td>45</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 29·57 | 42 | 10 a.m. | 29·60 | 45 | 3 p.m. |
| Reading.      | Temperature. |         |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29·57         | 42           | 10 a.m. |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29·60         | 45           | 3 p.m.  |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 15            | "            | 2,127   | 5·0        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 16            | "            | 2,148   | 2·4        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 17            | "            | 2,172   | 8·0        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 18            | "            | 2,083   | 5·0        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19            | "            | 2,147   | 8·8        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20            | "            | 2,155   | 6·4        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 21            | "            | 2,178   | 5·2        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 22            | "            | 2,192   | 8·2        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |



## RANGE AND ACCURACY—continued.

## COMMON SHELL (filled with sand).

SHOEBURYNESS.

*Particulars, &c. of Shell and Ammunition.*

Weight, 11 lbs. 10·8 ozs.

Diameter, 2·96 inches.

Length, 9·01 in.

Bursting charge, 7 oz.

Length of cartridge, 7·5 inches.

Diameter of cartridge, 2·9 in.

Brand of powder, A4.

Charge,  $1\frac{3}{4}$  lbs.

Wad, nil.

Service sponge.

*Note.*—Wet sponge used for first 8 rounds.

| No. of Round. | Elevation. | Range. | 1st Graze. | 2nd Graze. |        | 3rd Graze. |        | Remarks.                                                                                                                                                                                                                                                                                                                            |
|---------------|------------|--------|------------|------------|--------|------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |            |        | Left.      | Range.     | Right. | Range.     | Right. |                                                                                                                                                                                                                                                                                                                                     |
|               | °          | Yards. | Yards.     | Yards.     | Yards. | Yards.     | Yards. | <i>April 4, 1864.</i>                                                                                                                                                                                                                                                                                                               |
| 1             | 0          | 524    | 3·8        | 1,945      | 41·6   | 2,700      | 300    | The gun was placed 15 feet to left of line.<br>Weather :—Hazy at 10 a.m.<br>Slight haze at 3 p.m.<br>Wind :—Direction, S.E. by E. ; force, 1 ;<br>10 a.m.<br>N.N.W. ; force, 1 ;<br>3 p.m.<br>Thermometer :—48 dry, 47 wet, 10 a.m.<br>60 " 58 " 3 p.m.<br>Reading. Temperature.<br>Barometer :—29·75 50 10 a.m.<br>29·95 62 3 p.m. |
| 2             | "          | 515    | 4·         | 1,824      | 31·4   | 2,720      | 38     |                                                                                                                                                                                                                                                                                                                                     |
| 3             | "          | 520    | 4·2        | 1,690      | 37·6   | 2,716      | 65     |                                                                                                                                                                                                                                                                                                                                     |

| No. of Round. | Elevation. | Range. | 1st Graze. |        | Remarks.                                                                  |
|---------------|------------|--------|------------|--------|---------------------------------------------------------------------------|
|               |            |        | Right.     | Left.  |                                                                           |
|               | °          | Yards. | Yards.     | Yards. | <i>April 27, 1864.</i>                                                    |
| 1             | 0          | 538    | 5·4        | —      | The gun was 15 feet right of line.                                        |
| 2             | "          | 536    | 5·4        | —      | Wind :—Direction, E. ; force, 3 ; 10 a.m.<br>" E.S.E. ; force, 4 ; 3 p.m. |
| 3             | "          | 530    | 5·4        | —      | Thermometer :—49 dry, 47 wet, 10 a.m.<br>50 " 48 " 3 p.m.                 |
| 4             | "          | 529    | 6·2        | —      | Reading. Temperature.<br>Barometer :—30·20 51 10 a.m.<br>30·20 53 3 p.m.  |
| 5             | "          | 513    | 4·4        | —      |                                                                           |
| 1             | 1          | 910    | 7·8        | —      | <i>April 27, 1864.</i>                                                    |
| 2             | "          | 921    | 7·6        | —      | The gun was 15 feet right of line.                                        |
| 3             | "          | 919    | 6·8        | —      |                                                                           |
| 4             | "          | 904    | 6·4        | —      |                                                                           |
| 5             | "          | 903    | 7·4        | —      |                                                                           |
|               |            |        |            |        | <i>April 11, 1864.</i>                                                    |
|               |            |        |            |        | The gun was placed 15 feet to left of the line.                           |
|               |            |        |            |        | Weather :—Very thick haze.                                                |
| 1             | 2          | 1,290  | —          | 3·4    | Wind :—Direction, W.N.W. ; force, nil ; 10 a.m.<br>" W.S.W. " 1 ; 3 p.m.  |
| 2             | "          | 1,292  | —          | 3·2    | Thermometer :—47 dry, 45 wet, 10 a.m.<br>50 " 51 " 3 p.m.                 |
| 3             | "          | 1,265  | —          | 3·4    | Reading. Temperature.<br>Barometer :—30·10 52 10 a.m.<br>30·05 54 3 p.m.  |
| 4             | "          | 1,317  | —          | 3·2    |                                                                           |
| 5             | "          | 1,304  | —          | 2·8    |                                                                           |
|               |            |        |            |        | <i>April 14, 1864.</i>                                                    |
|               |            |        |            |        | The gun was in line.                                                      |
| 1             | 3          | 1,504  | 2·0        | —      | Weather :—Very slight haze on water, 10 a.m.<br>Clear, 3 p.m.             |
| 2             | "          | 1,633  | 4·0        | —      | Wind :—Direction, E. ; force, 4 ; 10 a.m.<br>" E. ; " 6 ; 6 p.m.          |
| 3             | "          | 1,601  | 6·0        | —      | Thermometer :—44 dry, 41 wet, 10 a.m.<br>50 " 47 " 3 p.m.                 |
| 4             | "          | 1,581  | 4·2        | —      |                                                                           |
| 5             | "          | 1,596  | 5·0        | —      |                                                                           |

RANGE AND ACCURACY.—COMMON SHELL—*continued.*

| No. of Round.   | Elevation. | Range. | 1st Graze. |        | Remarks.                                          |
|-----------------|------------|--------|------------|--------|---------------------------------------------------|
|                 |            |        | Right.     | Left.  |                                                   |
| April 14, 1864. |            |        |            |        |                                                   |
| 1               | 0          | Yards. | Yards.     | Yards. | The gun was in the line.                          |
| 2               | 4          | 1,949  | 4.0        | —      |                                                   |
| 3               | "          | 1,942  | 5.0        | —      | Reading. Temperature.                             |
| 4               | "          | 1,957  | 5.4        | —      | Barometer :—30.00 51 10 a.m.                      |
| 5               | "          | 1,884  | 6.0        | —      | 30.05 59 3 p.m.                                   |
| 5               | "          | 1,961  | 4.6        | —      |                                                   |
| April 14, 1864. |            |        |            |        |                                                   |
| 1               | 5          | 2,190  | 10.4       | —      | The gun was in the line.                          |
| 2               | "          | 2,247  | 9.6        | —      |                                                   |
| 3               | "          | 2,213  | 11.2       | —      |                                                   |
| 4               | "          | 2,215  | 9.0        | —      |                                                   |
| 5               | "          | 2,260  | 11.8       | —      |                                                   |
| April 15, 1864. |            |        |            |        |                                                   |
| 1               | 6          | 2,600  | 6.4        | —      | The gun was 15 feet left of line.                 |
| 2               | "          | 2,610  | 3.0        | —      | Weather :—Hazy.                                   |
| 3               | "          | 2,552  | 6.0        | —      | Wind :—Direction, S.E. by S. ; force, 3 ; 10 a.m. |
| 4               | "          | 2,596  | 4.0        | —      | " " " 4 ; 3 p.m.                                  |
| 5               | "          | 2,602  | 5.4        | —      | Thermometer :—51 dry, 48 wet, 10 a.m.             |
|                 |            |        |            |        | 55 " 52 " 3 p.m.                                  |
|                 |            |        |            |        | Reading. Temperature.                             |
|                 |            |        |            |        | Barometer :—29.75 52 10 a.m.                      |
|                 |            |        |            |        | 29.75 56 3 p.m.                                   |
| April 15, 1864. |            |        |            |        |                                                   |
| 1               | 7          | 2,900  | 8.0        | —      | The gun was 15 feet to left of line.              |
| 2               | "          | 2,870  | 7.0        | —      |                                                   |
| 3               | "          | 2,894  | 6.2        | —      |                                                   |
| 4               | "          | 2,890  | 9.4        | —      |                                                   |
| 5               | "          | 2,929  | 11.2       | —      |                                                   |
| April 25, 1864. |            |        |            |        |                                                   |
| 1               | 8          | 3,034  | 32.0       | —      | The gun was 15 feet right of line.                |
| 2               | "          | 3,103  | 36.4       | —      | Weather :—Clear.                                  |
| 3               | "          | 3,162  | 29.6       | —      | Wind :—Direction, E. ; force, 4 ; 10 a.m.         |
| 4               | "          | 3,032  | 32.0       | —      | " E.S.E. ; " 3 ; 3 p.m.                           |
| 5               | "          | 3,036  | 29.6       | —      | Thermometer :—51 dry, 48 wet, 10 a.m.             |
|                 |            |        |            |        | 52 " 50 " 3 p.m.                                  |
|                 |            |        |            |        | Reading. Temperature.                             |
|                 |            |        |            |        | Barometer :—30.20 52 10 a.m.                      |
|                 |            |        |            |        | 30.15 55 3 p.m.                                   |
| April 26, 1864. |            |        |            |        |                                                   |
| 1               | 9          | 3,432  | 7.4        | —      | The gun was 15 feet right of line.                |
| 2               | "          | 3,345  | 9.8        | —      | Weather :—Hazy, 10 a.m.                           |
| 3               | "          | 3,358  | 8.0        | —      | Clear, 3 p.m.                                     |
| 4               | "          | 3,357  | 4.8        | —      | Wind :—Direction, N.E. by E. ; force, 1 ; 10 a.m. |
| 5               | "          | 3,335  | 7.4        | —      | " E. by S. ; " 2 ; 3 p.m.                         |
|                 |            |        |            |        | Thermometer :—52 dry, 49 wet, 10 a.m.             |
|                 |            |        |            |        | 52 " 49 " 3 p.m.                                  |
|                 |            |        |            |        | Reading. Temperature.                             |
|                 |            |        |            |        | Barometer :—30.20 52 10 a.m.                      |
|                 |            |        |            |        | 30.35 53 3 p.m.                                   |
| April 27, 1864. |            |        |            |        |                                                   |
| 1               | 10         | 3,552  | 53.0       | —      | The gun was 15 feet right of line.                |
| 2               | "          | 3,542  | 51.6       | —      | Weather :—Hazy, 10 a.m.                           |
| 3               | "          | 3,568  | 48.0       | —      | Slight haze, 3 p.m.                               |
| 4               | "          | 3,510  | 50.0       | —      | For weather, see 0°.                              |
| 5               | "          | 3,490  | 52.0       | —      |                                                   |



## RANGE AND ACCURACY—continued.

## SEGMENT SHELL (weighted with burster).

SHOEBURYNESS.

*Particulars, &c. of Shell and Ammunition.*

Weight, 10 lbs. 6·4 oz.  
Length, 7·25 in.  
Diameter, 2·96 in.  
Bursting charge, 520 grains.

Length of cartridge, 7·5 in. No lubricator,  
dry sponge.  
Diameter of cartridge, 2·9 in.  
Charge,  $1\frac{3}{4}$  lbs.  
Wad, junk, and stearine used after April 28/64.

| No. of Round. | Elevation. | Range. | 1st Graze. | 2nd Graze. |        | 3rd Graze. |        | Remarks.                                                                                |
|---------------|------------|--------|------------|------------|--------|------------|--------|-----------------------------------------------------------------------------------------|
|               |            |        | Left.      | Range.     | Right. | Range.     | Right. |                                                                                         |
|               | °          | Yards. | Yards.     | Yards.     | Yards. | Yards.     | Yards. | <i>April 4, 1864.</i>                                                                   |
| 1             | 0          | 529    | 3·4        | 2,029      | 26·    | 3,258      | 135    | The gun was 15 feet left of line.<br>Weather :—Hazy at 10 a.m.<br>Slight haze at 3 p.m. |
| 2             | "          | 525    | 3·8        | 1,825      | 5·4    | 3,555      | 175    | Wind :—Direction, S.E. by E.; force, 1; 10 a.m.<br>" N.N.W.; " 1; 3 p.m.                |
| 3             | "          | 497    | 2·6        | 1,190      | 37·4   | 3,340      | 75     | Thermometer :—48 dry, 47 wet, 10 a.m.<br>60 " 58 " 3 p.m.                               |
| 4             | "          | 537    | 4·         | 2,400      | 62·    | 3,149      | 83     | Reading. Temperature.<br>Barometer :—29·75 50 10 a.m.<br>29·95 62 3 p.m.                |
| 5             | "          | 545    | 3·6        | 1,940      | 27·4   | 3,040      | 29     | Note.—Wet sponge used for this day only.                                                |

| No. of Round. | Elevation. | Range. | 1st Graze. |        | Remarks.                                                                 |
|---------------|------------|--------|------------|--------|--------------------------------------------------------------------------|
|               |            |        | Right.     | Left.  |                                                                          |
|               | °          | Yards. | Yards.     | Yards. | <i>April 27, 1864.</i>                                                   |
| 1             | 1          | 926    | 6·0        | —      | The gun was 15 feet right of line.                                       |
| 2             | "          | 930    | 6·4        | —      | Weather :—Hazy, 10 a.m.                                                  |
| 3             | "          | 913    | 6·6        | —      | Slight haze, 3 p.m.                                                      |
| 4             | "          | 894    | 6·8        | —      | Wind :—Direction, E.; force, 3; 10 a.m.                                  |
| 5             | "          | 917    | 6·4        | —      | " E.S.E.; " 4; 3 p.m.                                                    |
|               |            |        |            |        | <i>April 11, 1864.</i>                                                   |
|               |            |        |            |        | The gun was 15 feet to left of line.                                     |
|               |            |        |            |        | Weather :—Very thick haze.                                               |
| 1             | 2          | 1,311  | —          | 4·4    | Wind :—Direction, W.N.W.; force, nil; 10 a.m.                            |
| 2             | "          | 1,290  | —          | 4·     | " W.S.W.; " 1; 3 p.m.                                                    |
| 3             | "          | 1,259  | —          | 4·4    | Thermometer :—47 dry, 45 wet, 10 a.m.                                    |
| 4             | "          | 1,294  | —          | 3·6    | 50 " 51 " 3 p.m.                                                         |
| 5             | "          | 1,270  | —          | 2·4    | Reading. Temperature.<br>Barometer :—30·10 52 10 a.m.<br>30·05 54 3 p.m. |
|               |            |        |            |        | <i>April 14, 1864.</i>                                                   |
| 1             | 3          | 1,625  | 4·0        | —      | The gun was in line.                                                     |
| 2             | "          | 1,644  | 4·0        | —      | Weather :—Very slight haze on water, 10 a.m.                             |
| 3             | "          | 1,657  | 3·0        | —      | Clear at 3 p.m.                                                          |
| 4             | "          | 1,618  | 4·2        | —      | Wind :—Direction, E.; force, 4; 10 a.m.                                  |
| 5             | "          | 1,610  | 4·0        | —      | " " " 6; 3 p.m.                                                          |

RANGE AND ACCURACY.—SEGMENT SHELL—*continued.*

| No. of Round. | Elevation. | Range. | 1st Graze. |        | Remarks.                                          |
|---------------|------------|--------|------------|--------|---------------------------------------------------|
|               |            |        | Right.     | Left.  |                                                   |
|               | °          | Yards. | Yards.     | Yards. | <i>April 14, 1864.</i>                            |
| 1             | 4          | 1,960  | 6·0        | —      | This gun was in line.                             |
| 2             | "          | 1,929  | 7·2        | —      | Thermometer :—44 dry, 41 wet, 10 a.m.             |
| 3             | "          | 1,956  | 3·6        | —      | 50 " 47 " 3 p.m.                                  |
| 4             | "          | 1,927  | 6·2        | —      | Reading. Temperature.                             |
| 5             | "          | 1,929  | 8·2        | —      | Barometer :—30·00 51 10 a.m.                      |
|               |            |        |            |        | 30·05 59 3 p.m.                                   |
|               |            |        |            |        | <i>April 14, 1864.</i>                            |
| 1             | 5          | 2,107  | 10·0       | —      |                                                   |
| 2             | "          | 2,200  | 9·6        | —      | This gun was in line.                             |
| 3             | "          | 2,244  | 11·0       | —      |                                                   |
| 4             | "          | 2,218  | 10·8       | —      |                                                   |
| 5             | "          | 2,249  | 13·0       | —      |                                                   |
|               |            |        |            |        | <i>April 15, 1864.</i>                            |
|               |            |        |            |        | This gun was 15 feet to left of line.             |
|               |            |        |            |        | Weather :—Hazy.                                   |
| 1             | 6          | 2,549  | 8·4        | —      | Wind :—Direction, S.E. by S. ; force, 3 ; 10 a.m. |
| 2             | "          | 2,612  | 6·4        | —      | " " " " 4 ; 3 p.m.                                |
| 3             | "          | 2,564  | 6·4        | —      | Thermometer :—51 dry, 48 wet, 10 a.m.             |
| 4             | "          | 2,596  | 4·4        | —      | 55 " 52 " 3 p.m.                                  |
| 5             | "          | 2,600  | 8·0        | —      | Reading. Temperature.                             |
|               |            |        |            |        | Barometer :—29·75 52 10 a.m.                      |
|               |            |        |            |        | 29·75 56 3 p.m.                                   |
|               |            |        |            |        | <i>April 15, 1864.</i>                            |
| 1             | 7          | 2,804  | 11·4       | —      |                                                   |
| 2             | "          | 2,841  | 1·2        | —      |                                                   |
| 3             | "          | 2,888  | 11·0       | —      | This gun was 15 feet left of line.                |
| 4             | "          | 2,907  | 11·4       | —      |                                                   |
| 5             | "          | 2,866  | 7·4        | —      |                                                   |
|               |            |        |            |        | <i>April 25, 1864.</i>                            |
|               |            |        |            |        | This gun was 15 feet right of line.               |
|               |            |        |            |        | Weather :—Clear.                                  |
| 1             | 8          | 2,937  | 23·0       | —      | Wind :—Direction, E. ; force, 4 ; 10 a.m.         |
| 2             | "          | 3,103  | 31·2       | —      | " E.S.E. ; " 3 ; 3 p.m.                           |
| 3             | "          | 3,127  | 34·0       | —      | Thermometer :—51 dry, 48 wet, 10 a.m.             |
| 4             | "          | 3,006  | 31·0       | —      | 52 " 50 " 3 p.m.                                  |
| 5             | "          | 3,058  | 34·4       | —      | Reading. Temperature.                             |
|               |            |        |            |        | Barometer :—30·20 52 10 a.m.                      |
|               |            |        |            |        | 30·15 55 3 p.m.                                   |
|               |            |        |            |        | <i>April 26, 1864.</i>                            |
|               |            |        |            |        | This gun was 15 feet right of line.               |
|               |            |        |            |        | Weather :—Hazy, 10 a.m.                           |
|               |            |        |            |        | Clear, 3 p.m.                                     |
| 1             | 9          | 3,364  | 14·8       | —      | Wind :—Direction, N.E. by E. ; force, 1 ; 10 a.m. |
| 2             | "          | 3,309  | 6·2        | —      | " E. by S. ; " 2 ; 3 p.m.                         |
| 3             | "          | 3,256  | 2·0        | —      | Thermometer :—52 dry, 49 wet, 10 a.m.             |
| 4             | "          | 3,423  | 10·0       | —      | 52 " 49 " 3 p.m.                                  |
| 5             | "          | 3,395  | 7·6        | —      | Reading. Temperature.                             |
|               |            |        |            |        | Barometer :—30·20 52 10 a.m.                      |
|               |            |        |            |        | 30·35 53 3 p.m.                                   |
|               |            |        |            |        | <i>April 26, 1864.</i>                            |
| 1             | 10         | 3,607  | 13·2       | —      |                                                   |
| 2             | "          | 3,482  | 16·8       | —      |                                                   |
| 3             | "          | 3,630  | 22·8       | —      | This gun was 15 feet right of line.               |
| 4             | "          | 3,658  | 26·4       | —      |                                                   |
| 5             | "          | 3,593  | 24·2       | —      |                                                   |



SEGMENT SHELL—*continued.*

| No. of Round. | Elevation.   | Range.  | 1st Graze. |        |        | Remarks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                |              |  |       |    |         |       |    |        |
|---------------|--------------|---------|------------|--------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|--------------|--|-------|----|---------|-------|----|--------|
|               |              |         | In Line.   | Right. | Left.  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
|               |              | Yards.  |            | Yards. | Yards. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 1             | 0            | 553     | —          | 1·2    | —      | <i>February 22, 1865.</i><br>This gun was in line.<br><br>Weather :—Thick haze on water.<br>Wind :—Direction, W. ; force, 2 ; 10 a.m.<br>„ S.W. by W. ; „ 1 ; 3 p.m.<br>Thermometer :—36 dry, 35 wet, 10 a.m.<br>39 „ 38 „ 3 p.m.<br><br>To correspond with Whitworth.<br>Ditto                   ditto.<br><br>Barometer :— <table><tr><td>Reading.</td><td>Temperature,</td><td></td></tr><tr><td>30·27</td><td>38</td><td>10 a.m.</td></tr><tr><td>30·25</td><td>41</td><td>3 p.m.</td></tr></table><br><br>Ditto                   ditto.<br>Ditto                   ditto. | Reading.       | Temperature, |  | 30·27 | 38 | 10 a.m. | 30·25 | 41 | 3 p.m. |
| Reading.      | Temperature, |         |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 30·27         | 38           | 10 a.m. |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 30·25         | 41           | 3 p.m.  |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 2             | „            | 561     | —          | 0·6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 3             | „            | 547     | —          | 1·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 4             | „            | 571     | —          | 0·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 5             | „            | 595     | —          | 0·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 6             | „            | 544     | Yes        | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 7             | „            | 546     | Yes        | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 8             | „            | 562     | —          | 0·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 9             | „            | 587     | —          | 0·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 10            | „            | 544     | —          | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 11            | „            | 540     | —          | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 12            | „            | 585     | —          | 0·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 13            | „            | 579     | —          | —      | 0·2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 14            | „            | 570     | Yes        | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 15            | „            | 590     | Yes        | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 16            | „            | 573     | Yes        | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 17            | „            | 564     | —          | 0·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 18            | „            | 554     | —          | 1·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 19            | „            | 543     | —          | 0·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 20            | „            | 557     | —          | 1·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 21            | „            | 575     | —          | 1·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 22            | „            | 562     | —          | 0·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 1             | 3            | 1,651   | —          | 2·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 2             | „            | 1,583   | —          | 1·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 3             | „            | 1,594   | —          | —      | 0·2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 4             | „            | 1,632   | —          | 0·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 5             | „            | 1,608   | —          | 4·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 6             | „            | 1,589   | —          | 5·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 7             | „            | 1,596   | —          | 1·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 8             | „            | 1,634   | Yes        | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 9             | „            | 1,530   | —          | 4·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 10            | „            | 1,607   | —          | 3·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 11            | „            | 1,530   | —          | 2·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 12            | „            | 1,594   | —          | 3·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 13            | „            | 1,606   | —          | —      | 9·8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 14            | „            | 1,618   | —          | 6·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 15            | „            | 1,704   | —          | —      | 2·0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 16            | „            | 1,669   | —          | —      | 1·4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 17            | „            | 1,610   | Yes        | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 18            | „            | 1,649   | —          | —      | 2·2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 19            | „            | 1,644   | —          | —      | 2·0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 20            | „            | 1,629   | —          | —      | 2·2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 21            | „            | 1,645   | —          | —      | 1·4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 22            | „            | 1,638   | —          | —      | 1·2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 1             | 5            | 2,266   | —          | —      | 6·2    | Corresponding round Whitworth broke up.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                |              |  |       |    |         |       |    |        |
| 2             | „            | 2,306   | Yes        | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 3             | „            | 2,299   | —          | —      | 1·4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 4             | „            | 2,238   | —          | 3·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 5             | „            | 2,351   | —          | 2·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 6             | „            | 2,297   | —          | —      | 10·0   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 7             | „            | 2,314   | Yes        | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 8             | „            | 2,298   | —          | —      | 0·6    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 9             | „            | 2,315   | —          | 6·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 10            | „            | 2,224   | —          | —      | 1·2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 11            | „            | 2,337   | —          | 1·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 12            | „            | 2,288   | —          | —      | 0·2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 13            | „            | 2,255   | —          | 2·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 14            | „            | 2,310   | —          | —      | 2·0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 15            | „            | 2,234   | —          | —      | 1·2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 16            | „            | 2,286   | —          | 5·6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 17            | „            | 2,292   | —          | —      | 1·0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 18            | „            | 2,251   | —          | 3·6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 19            | „            | 2,250   | —          | 3·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 20            | „            | 2,223   | —          | 1·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 21            | „            | 2,298   | —          | 3·6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
| 22            | „            | 2,368   | —          | —      | 3·0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |              |  |       |    |         |       |    |        |
|               |              |         |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Thomas Wilson. |              |  |       |    |         |       |    |        |

## SEGMENT SHELL—continued.

| No. of Round. | Elevation. | Range.   | 1st Graze. |        |        | Remarks.                                                                 |
|---------------|------------|----------|------------|--------|--------|--------------------------------------------------------------------------|
|               |            |          | In Line.   | Right. | Left.  |                                                                          |
|               |            | Yards.   |            | Yards. | Yards. |                                                                          |
| 1             | 7          | 2,966    | —          | 8.0    | —      | <i>February 23, 1865.</i><br>This gun was 15 feet right of line.         |
| 2             | "          | 2,768    | —          | 10.8   | —      |                                                                          |
| 3             | "          | 2,764    | —          | 5.2    | —      | Weather:—Very thick haze on water, 10 a.m.                               |
| 4             | "          | 2,792    | —          | 3.0    | —      | Hazy, 3 p.m.                                                             |
| 5             | "          | 2,770    | —          | 13.4   | —      | Wind:—Direction, W. by N.; force, 3; 10 a.m.                             |
| 6             | "          | 2,848    | —          | —      | 0.2    | " N.W. by W.; " 3; 3 p.m.                                                |
| 7             | "          | 2,750    | —          | 4.4    | —      | Thermometer:—42 dry, 41 wet, 10 a.m.                                     |
| 8             | "          | 2,737    | —          | 7.4    | —      | 47 " 46 " 3 p.m.                                                         |
| 9             | "          | 2,706    | —          | 1.2    | —      |                                                                          |
| 10            | "          | 2,718    | —          | 6.0    | —      | Barometer:— <sup>Reading.</sup> 30.30 <sup>Temperature.</sup> 41 10 a.m. |
| 11            | "          | 2,796    | —          | 1.0    | —      | 30.30 46 3 p.m.                                                          |
| 12            | "          | 2,878    | —          | —      | 3.2    |                                                                          |
| 13            | "          | 2,916    | —          | —      | 1.2    |                                                                          |
| 14            | "          | 2,875    | —          | —      | 0.4    | } To correspond with Whitworth broken at muzzle.                         |
| 15            | "          | 2,801    | —          | —      | 1.0    |                                                                          |
| 16            | "          | 2,897    | —          | 3.0    | —      |                                                                          |
| 17            | "          | 2,690    | Yes.       | —      | —      |                                                                          |
| 18            | "          | 2,828    | —          | 2.6    | —      |                                                                          |
| 19            | "          | 2,782    | —          | —      | 6.6    | Do. do.                                                                  |
| 20            | "          | 2,884    | —          | 1.2    | —      |                                                                          |
| 21            | "          | 2,835    | —          | 6.0    | —      |                                                                          |
| 22            | "          | 2,932    | —          | 7.0    | —      |                                                                          |
| 1             | 10         | 3,715    | —          | 5.8    | —      |                                                                          |
| 2             | "          | 3,618    | —          | —      | 0.4    |                                                                          |
| 3             | "          | 3,571    | —          | 1.4    | —      | To correspond with B.L. Armstrong lost.                                  |
| 4             | "          | 3,640    | —          | —      | 1.2    | } To correspond with Whitworth broken up.                                |
| 5             | "          | 3,640    | —          | 8.0    | —      |                                                                          |
| 6             | "          | 3,647    | —          | 3.4    | —      |                                                                          |
| 7             | "          | 3,651    | —          | 5.0    | —      | Do. do.                                                                  |
| 8             | "          | 3,446    | —          | —      | 6.2    |                                                                          |
| 9             | "          | 3,648    | —          | 6.0    | —      |                                                                          |
| 10            | "          | 3,720    | —          | —      | 0.8    | Do. do.                                                                  |
| 11            | "          | 3,574    | —          | 2.0    | —      |                                                                          |
| 12            | "          | 3,704    | —          | 1.0    | —      | Do. do.                                                                  |
| 13            | "          | 3,721    | —          | 8.4    | —      |                                                                          |
| 14            | "          | 3,304    | —          | —      | 0.4    |                                                                          |
| 15            | "          | 3,565    | —          | 8.0    | —      |                                                                          |
| 16            | "          | 3,684    | —          | 13.0   | —      |                                                                          |
| 17            | "          | 3,550    | —          | 4.8    | —      |                                                                          |
| 18            | "          | 3,462    | —          | 3.4    | —      |                                                                          |
| 19            | "          | 3,638    | —          | 3.2    | —      |                                                                          |
| 20            | "          | Not seen | —          | —      | —      |                                                                          |
| 21            | "          | 3,494    | —          | 0.2    | —      |                                                                          |
| 22            | "          | 3,668    | —          | 1.4    | —      |                                                                          |
| 23            | "          | 3,490    | —          | 2.6    | —      |                                                                          |
| 24            | "          | 3,534    | —          | 0.4    | —      |                                                                          |
|               |            |          |            |        |        | <i>March 7, 1865.</i>                                                    |
| 1             | 3          | 1,502    | —          | —      | 6.4    |                                                                          |
| 2             | "          | 1,497    | —          | —      | 5.6    |                                                                          |
| 3             | "          | 1,541    | —          | —      | 4.8    | Without lubricators or wad.                                              |
| 4             | "          | 1,486    | —          | —      | 3.4    |                                                                          |
| 5             | "          | 1,523    | —          | —      | 6.0    |                                                                          |
| 6             | "          | 1,508    | —          | —      | 7.2    |                                                                          |
| 7             | "          | 1,502    | —          | —      | 6.8    |                                                                          |
| 8             | "          | 1,512    | —          | —      | 6.0    |                                                                          |
| 9             | "          | 1,5      | —          | —      | 7.6    |                                                                          |
| 10            | "          | 1,518    | —          | —      | 6.0    |                                                                          |
| 11            | "          | 1,505    | —          | —      | 5.6    |                                                                          |
| 12            | "          | —        | —          | —      | —      | Broke up.                                                                |
| 13            | "          | 1,509    | —          | —      | 7.4    |                                                                          |
| 14            | "          | 1,542    | —          | —      | 7.4    |                                                                          |
| 15            | "          | 1,507    | —          | —      | 7.8    |                                                                          |
| 16            | "          | 1,548    | —          | —      | 7.0    |                                                                          |
| 17            | "          | 1,499    | —          | —      | 8.0    |                                                                          |
| 18            | "          | —        | —          | —      | —      | Broke up.                                                                |
| 19            | "          | 1,535    | —          | —      | 8.0    |                                                                          |
| 20            | "          | 1,469    | —          | —      | 7.0    |                                                                          |
| 21            | "          | 1,433    | —          | —      | 5.2    |                                                                          |
| 22            | "          | 1,499    | —          | —      | 7.6    |                                                                          |
| 23            | "          | 1,503    | —          | —      | 6.4    |                                                                          |



## TARGET PRACTICE.

## SOLID SHOT.

*April 5, 1864.*

The firing was carried on against wooden targets divided into squares of 12 inches, the inscribed circle in centre square being the bull's-eye.

RANGE, 200 yards. Five trial shots. Elevation, 13'. Deflection, 2' left.

No. 1. 11 inches from centre.  
 „ 2. 5 „ „  
 „ 3. 4 „ „  
 „ 4. 6 „ „  
 „ 5. 9.75 „ „

*April 6, 1864—continued.*

RANGE, 600 yards. Two trial shots. Elevation, 54'. Deflection, 5' left.

No. 1. 42.5 inches.  
 „ 2. 14.75 „  
 „ 3. 24.5 „  
 „ 4. 16.5 „  
 „ 5. 36.5 „

*April 7, 1864.*

RANGE, 800 yards. Three trial shots. Elevation, 1° 19'. Deflection, 7' left.

No. 1. 37 inches.  
 „ 2. 28.25 „  
 „ 3. 47 „  
 „ 4. 9 „  
 „ 5. 36 „

RANGE, 300 yards. Five trial shots. Elevation, 22'. Deflection, 3' left.

No. 1. centre.  
 „ 2. 11.5 inches.  
 „ 3. 22.75 „  
 „ 4. 5.5 „  
 „ 5. 12.5 „

RANGE, 900 yards. Five trial shots. Elevation, 1° 32'. Deflection, 11' left.

No. 1. 68.5 inches.  
 „ 2. miss.  
 „ 3. 15 inches.  
 „ 4. 10.5 „  
 „ 5. miss.

RANGE, 400 yards. Five trial shots. Elevation, 29'. Deflection, 4' left.

No. 1. 22.75 inches.  
 „ 2. 7.5 „  
 „ 3. 9.5 „  
 „ 4. 12 „  
 „ 5. 19.25 „

*April 8, 1864.*

RANGE, 1,300 yards. Five trial shots. Elevation, 2° 38', Nos. 1 and 2; 2° 36', Nos. 3, 4, 5. Deflection, 12' left.

No. 1. miss.  
 „ 2. 48 inches from centre.  
 „ 3. 50 „ „  
 „ 4. 53 „ „  
 „ 5. miss.

*April 6, 1864.*

RANGE, 500 yards. Three trial shots. Elevation, 38'. Deflection, 5' left.

No. 1. 23.75 inches.  
 „ 2. 8.25 „  
 „ 3. 13.75 „  
 „ 4. 25 „  
 „ 5. 19.75 „

## TARGET PRACTICE.—SOLID SHOT—continued.

April 29, 1864.

May 10 and 12, 1864.

RANGE, 1,700 yards. Three 9-foot targets. Five trial shots not recorded.

RANGE, 2,000 yards. Three 9-foot targets. Five trial shots not recorded.

| No. of Round. | Inches from Centre. | 1st Graze. |       |        |        | No. of Round. | Inches from Centre. | 1st Graze. |       |        |        |
|---------------|---------------------|------------|-------|--------|--------|---------------|---------------------|------------|-------|--------|--------|
|               |                     | Right.     | Left. | Short. | Over.  |               |                     | Right.     | Left. | Short. | Over.  |
|               |                     | Feet.      | Feet. | Yards. | Yards. |               |                     | Feet.      | Feet. | Yards. | Yards. |
| 1             | —                   | 5          | —     | —      | 30     | 1             | —                   | 9          | —     | 75     | —      |
| 2             | —                   | 6          | —     | —      | 55     | 2             | —                   | 6          | —     | —      | 82     |
| 3             | —                   | 2          | —     | —      | 50     | 3             | —                   | —          | 18    | 5      | —      |
| 4             | —                   | 4          | —     | —      | 55     | 4             | —                   | —          | 2     | 20     | —      |
| 5             | 23 $\frac{3}{4}$    | —          | —     | —      | —      | 5             | —                   | 4          | —     | 78     | —      |
| 6             | —                   | —          | 2     | 10     | —      | 6             | —                   | 9          | —     | 44     | —      |
| 7             | 35                  | —          | —     | —      | —      | 7             | —                   | —          | —     | 68     | —      |
| 8             | —                   | 4          | —     | —      | 53     | 8             | —                   | 6          | —     | 50     | —      |
| 9             | —                   | 4          | —     | —      | 50     | 9             | —                   | —          | 4     | 13     | —      |
| 10            | 23                  | —          | —     | —      | —      | 10            | —                   | —          | 1     | 16     | —      |
| 11            | 43                  | —          | —     | —      | —      | 11            | —                   | —          | 4     | —      | 54     |
| 12            | —                   | 2          | —     | 55     | —      | 12            | —                   | 3          | —     | 10     | —      |
| 13            | —                   | 5          | —     | —      | 55     | 13            | —                   | —          | 3     | —      | 40     |
| 14            | —                   | —          | —     | —      | 50     | 14            | —                   | 2          | —     | —      | 47     |
| 15            | 67 $\frac{1}{2}$    | —          | —     | —      | —      | 15            | —                   | —          | 4     | 44     | —      |
| 16            | —                   | 2          | —     | —      | 50     | 16            | 60                  | —          | —     | —      | —      |
| 17            | —                   | —          | —     | 35     | —      | 17            | —                   | —          | —     | —      | 30     |
| 18            | 37 $\frac{3}{4}$    | —          | —     | —      | —      | 18            | —                   | 1          | —     | 90     | —      |
| 19            | —                   | 2          | —     | 6      | —      | 19            | —                   | —          | 4     | —      | 35     |
| 20            | —                   | 2          | —     | 2      | —      | 20            | —                   | 8          | —     | 42     | —      |

May 11 and 12, 1864.

RANGE, 3,000 yards. Five trial shots not recorded.

| No. of Round. | Inches from Centre. | 1st Graze. |       |        |        |
|---------------|---------------------|------------|-------|--------|--------|
|               |                     | Right.     | Left. | Short. | Over.  |
|               |                     | Feet.      | Feet. | Yards. | Yards. |
| 1             | —                   | —          | 18    | —      | 12     |
| 2             | —                   | 3          | —     | 68     | —      |
| 3             | —                   | —          | 2     | —      | 52     |
| 4             | —                   | —          | 36    | 35     | —      |
| 5             | —                   | —          | 18    | —      | 18     |
| 6             | —                   | 17         | —     | 46     | —      |
| 7             | —                   | —          | 17    | —      | —      |
| 8             | —                   | —          | 30    | 44     | —      |
| 9             | —                   | 9          | —     | 57     | —      |
| 10            | 128                 | —          | —     | —      | —      |
| 11            | —                   | 2          | —     | —      | 36     |
| 12            | —                   | —          | 13    | —      | 41     |
| 13            | —                   | 6          | —     | —      | 88     |
| 14            | —                   | 3          | —     | 17     | —      |
| 15            | —                   | 18         | —     | —      | 20     |
| 16            | —                   | 20         | —     | —      | 54     |
| 17            | —                   | 6          | —     | —      | 56     |
| 18            | —                   | —          | 2     | —      | 140    |
| 19            | —                   | 3          | —     | 94     | —      |
| 20            | —                   | 24         | —     | —      | 66     |



TARGET PRACTICE—*continued*.

## SEGMENT SHELL (BLIND).

*April 28 and 29, 1864.**May 18, 1864.*

RANGE, 1,500 yards. Three 9-foot targets. Five trial shots not recorded.

RANGE, 2,600 yards. Three 9-foot targets. Five trial shots not recorded.

| No. of Round. | Inches from Centre. | 1st Graze. |       |        |        | No. of Round. | Inches from Centre. | 1st Graze. |       |        |        |
|---------------|---------------------|------------|-------|--------|--------|---------------|---------------------|------------|-------|--------|--------|
|               |                     | Right.     | Left. | Over.  | Short. |               |                     | Right.     | Left. | Short. | Over.  |
|               |                     | Feet.      | Feet. | Yards. | Yards. |               |                     | Feet.      | Feet. | Yards. | Yards. |
| 1             | —                   | —          | —     | —      | 52     | 1             | —                   | 13         | —     | 80     | —      |
| 2             | —                   | —          | —     | —      | 15     | 2             | —                   | —          | 15    | —      | 25     |
| 3             | —                   | —          | —     | 46     | —      | 3             | —                   | 7          | —     | 70     | —      |
| 4             | 52 $\frac{1}{4}$    | —          | —     | —      | —      | 4             | 57 $\frac{1}{2}$    | —          | —     | —      | —      |
| 5             | 31 $\frac{1}{2}$    | —          | —     | —      | —      | 5             | —                   | —          | 9     | 25     | —      |
| 6             | 57                  | —          | —     | —      | —      | 6             | —                   | 18         | —     | 30     | —      |
| 7             | —                   | —          | —     | 120    | —      | 7             | —                   | 6          | —     | 50     | —      |
| 8             | —                   | —          | —     | 50     | —      | 8             | —                   | —          | —     | —      | 40     |
| 9             | 92                  | —          | —     | —      | —      | 9             | —                   | —          | 5     | —      | 60     |
| 10            | —                   | —          | —     | —      | 18     | 10            | —                   | —          | —     | 30     | —      |
| 11            | —                   | —          | —     | —      | 15     | 11            | —                   | —          | —     | —      | 40     |
| 12            | 121                 | —          | —     | —      | —      | 12            | —                   | —          | 15    | 210    | —      |
| 13            | 90 $\frac{1}{2}$    | —          | —     | —      | —      | 13            | —                   | —          | 3     | —      | 30     |
| 14            | —                   | —          | 3     | —      | 60     | 14            | —                   | 9          | —     | 90     | —      |
| 15            | —                   | —          | 2     | —      | 15     | 15            | —                   | —          | —     | 60     | —      |
| 16            | —                   | —          | 2     | —      | 6      | 16            | 122 $\frac{3}{4}$   | —          | —     | —      | —      |
| 17            | —                   | —          | 3     | —      | 12     | 17            | —                   | 12         | —     | 70     | —      |
| 18            | —                   | —          | 4     | —      | 40     | 18            | —                   | —          | —     | —      | 100    |
| 19            | —                   | —          | 2     | —      | 55     | 19            | —                   | —          | 9     | 30     | —      |
| 20            | 56                  | —          | —     | —      | —      | 20            | —                   | —          | —     | 100    | —      |

*May 19, 1864.*

RANGE, 3,000 yards. Three 9-foot targets. Three trial shots not recorded.

| No. of Round. | Inches from Centre. | 1st Graze. |       |        |        |
|---------------|---------------------|------------|-------|--------|--------|
|               |                     | Right.     | Left. | Short. | Over.  |
|               |                     | Feet.      | Feet. | Yards. | Yards. |
| 1             | —                   | —          | 13    | —      | 20     |
| 2             | —                   | 12         | —     | —      | 94     |
| 3             | —                   | —          | 9     | 75     | —      |
| 4             | —                   | 15         | —     | 115    | —      |
| 5             | —                   | 15         | —     | 156    | —      |
| 6             | —                   | 14         | —     | 56     | —      |
| 7             | —                   | —          | —     | 75     | —      |
| 8             | —                   | —          | 15    | —      | 90     |
| 9             | —                   | —          | 2     | —      | 128    |
| 10            | —                   | 16         | —     | —      | 144    |
| 11            | —                   | —          | 5     | 3      | —      |
| 12            | —                   | —          | 24    | 108    | —      |
| 13            | —                   | 9          | —     | —      | 83     |
| 14            | —                   | —          | —     | —      | 160    |
| 15            | —                   | 12         | —     | —      | 151    |
| 16            | —                   | 12         | —     | —      | 84     |
| 17            | —                   | 8          | —     | 6      | —      |
| 18            | —                   | —          | —     | 30     | —      |
| 19            | —                   | —          | 2     | 38     | —      |
| 20            | —                   | —          | 4     | —      | 46     |

TARGET PRACTICE—continued.

COMMON SHELL (BLIND).

April 6, 1864.

RANGE, 700 yards. One 9 ft. target. Two trial shots. Elevation 1° 7'. Deflection, 7' left.

- No. 1. 15·5 inches.
- ” 2. 16·5 ”
- ” 3. 37 ”
- ” 4. 13·5 ”
- ” 5. 32 ”

April 28, 1864.

RANGE, 1,200 yards. Three 9-foot targets. Five trial shots not recorded.

| No. of Round. | Inches from Centre. | 1st Graze. |       |        |        |
|---------------|---------------------|------------|-------|--------|--------|
|               |                     | Right.     | Left. | Short. | Over.  |
|               |                     | Feet.      | Feet. | Yards. | Yards. |
| 1             | —                   | —          | —     | —      | 54     |
| 2             | 58½                 | —          | —     | —      | —      |
| 3             | —                   | —          | —     | —      | —      |
| 4             | 31½                 | —          | —     | —      | —      |
| 5             | —                   | —          | —     | —      | 56     |
| 6             | 60½                 | —          | —     | —      | —      |
| 7             | 44½                 | —          | —     | —      | —      |
| 8             | 37                  | —          | —     | —      | —      |
| 9             | 40                  | —          | —     | —      | —      |
| 10            | 33½                 | —          | —     | —      | —      |
| 11            | —                   | —          | —     | 3      | —      |
| 12            | 12½                 | —          | —     | —      | —      |
| 13            | 19½                 | —          | —     | —      | —      |
| 14            | 41                  | —          | —     | —      | —      |
| 15            | 20                  | —          | —     | —      | —      |
| 16            | —                   | —          | —     | 8      | —      |
| 17            | 33½                 | —          | —     | —      | —      |
| 18            | 55½                 | —          | —     | —      | —      |
| 19            | 38½                 | —          | —     | —      | —      |
| 20            | —                   | —          | —     | —      | 56     |

## EXPERIMENTS AGAINST EARTHWORKS AND ABBATIS.

*April 8, 1864.*

The practice was carried on against an earthwork with the embrasure revetted with Tyler's gabions. The work was armed with cast-iron guns on garrison carriages, having wood figures round the gun to represent men. Two 9-feet targets were placed 6 feet in rear of the guns.

RANGE, 1,300 yards.

The firing carried on against embrasure.

| —  | Elevation. | Deflection. | Projectile. | Fuze.                |
|----|------------|-------------|-------------|----------------------|
| 1  | 2 44       | 16 left     | Solid shot  | —                    |
| 2  | "          | 17 "        | "           | —                    |
| 3  | "          | 17 "        | "           | —                    |
| 4  | "          | 17 "        | "           | —                    |
| 5  | "          | 18 "        | "           | —                    |
| 6  | 2 43       | 19 "        | Seg. shell  | 2·05 and percussion. |
| 7  | 2 44       | 19 "        | "           | " "                  |
| 8  | "          | 20 "        | "           | 2 " "                |
| 9  | "          | 20 "        | "           | 2·05 " "             |
| 10 | "          | 20 "        | "           | " "                  |

Owing to the nature of the practice the general results of the practice alone could be recorded :—

On target ; 1 through ; no men hit ; 10 hits ; gun struck.

RANGE, 900 yards.

| —  | Elevation. | Deflection. | Projectile. | Fuze.         |
|----|------------|-------------|-------------|---------------|
| 1  | 1 35       | 9 left      | Solid shot  | —             |
| 2  | "          | 11 "        | "           | —             |
| 3  | "          | 11 "        | "           | —             |
| 4  | "          | 12 "        | "           | —             |
| 5  | "          | 12 "        | "           | —             |
| 6  | "          | 11 "        | Seg. shell  | 1·4 and Per.  |
| 7  | "          | 11 "        | "           | "             |
| 8  | "          | 11 "        | "           | "             |
| 9  | "          | 11 "        | "           | "             |
| 10 | "          | 11 "        | "           | "             |
| 11 | "          | 11 "        | Com. shell  | Percus. only. |
| 12 | "          | 11 "        | "           | "             |
| 13 | "          | 11 "        | "           | "             |
| 14 | "          | 11 "        | "           | "             |
| 15 | "          | 11 "        | "           | "             |
| 16 | "          | 11 "        | "           | "             |
| 17 | "          | 11 "        | "           | "             |
| 18 | "          | 11 "        | "           | "             |
| 19 | "          | 11 "        | "           | "             |
| 20 | "          | 11 "        | "           | "             |

The common shell practice to damage the merlon. The solid shot and segment shell against the embrasure.

The general results are as follows :—

On target, 12 lodged ; 7 through ; 6 struck ; 1 figure hit.

*April 11, 1864.*

700 yards, at embrasure only.

| —  | Elevation. | Deflection. | Projectile. | Fuze.                |
|----|------------|-------------|-------------|----------------------|
| 1  | 1 12       | 5 left      | Shot        | —                    |
| 2  | "          | 10 "        | "           | —                    |
| 3  | "          | 10 "        | "           | —                    |
| 4  | "          | 11 "        | "           | —                    |
| 5  | 1 14       | 11 "        | "           | —                    |
| 6  | "          | 11 "        | Seg. shell  | 1·05 and percussion. |
| 7  | 1 15       | 11 "        | "           | " "                  |
| 8  | "          | 8 "         | "           | " "                  |
| 9  | "          | 8 "         | "           | " "                  |
| 10 | "          | 8 "         | "           | " "                  |
| 11 | 1 13       | 8 "         | Com. shell  | Percussion.          |
| 12 | 1 12       | 8 "         | "           | "                    |
| 13 | 1 13·5     | 8 "         | "           | "                    |
| 14 | 1 15       | 8 "         | "           | "                    |
| 15 | "          | 8 "         | "           | "                    |

The general results are as follows :—

On target, 27 through ; 2 lodged ; 3 struck ; 3 figures struck.

## ABBATIS.

RANGE, 600 yards.

5 solid shot.

5 segment shell. Time and percussion fuze.

5 common shell. " " "

The abbatiss was considerably damaged by the solid shot and segment shell, which made a complete passage through it, and rendered it practicable for assault. The common shell did little damage.

## STOCKADES.

*Shoeburyness, April 18, 1864.*

The stockade 18 feet long, 8 feet high, consisted of rough elm timbers freshly felled 12 feet long, and 14 inches in thickness; the ends were sunk 4 feet in the ground and the stockade strengthened by a strong oak brace in rear.

RANGE, 800 yards.

Targets 6 feet in rear to show the effect of the shell.

10 S. shell.  
10 C. shell,

were fired; the stockade although but little damaged owing to the wood being green afforded no protection whatever, the targets in rear being broken to pieces.

As regards destructive effect there was no choice between the guns.

## WALLS.

The wall, 18 feet long, 8 feet high, 28 inches in thickness, was built of the best stock bricks and cement.

RANGE, 1,150 yards.

Targets six feet in rear to show the effect of the shell.

5 rounds solid shot.  
5 „ S. shell.  
5 „ C. shell

were fired; at the conclusion of the practice there appeared to be very little difference in the amount of damage done by the guns.

That fired at by—

B.L. Armstrong was most damaged.  
M.L. Armstrong „ next.  
Whitworth „ next.

As regards the targets in rear, the relative damage done by the splinters of shells was as follows :—

M.L. Armstrong, most damage, most distributed.  
B.L. Armstrong, next „ most concentrated.  
Whitworth, least damage, considerably less so than either of the other two.

## PRACTICE WITH SEGMENT SHELL AGAINST FIELD ARTILLERY.

A 6-pounder field gun was placed in action with limber in rear; dummy figures were placed to represent the gun detachment.

RANGE, 1,000 yards.

A screen was placed so as to insure the shell bursting 25 yards in front of the gun.

1. Hit the screen 4 feet from the ground; 6 of the gun detachment hit; the tire of the gun wheel broken; 9 hits on carriage; 3 hits on limber.
2. Hit screen 5 feet from the ground; 3 of the gun detachment hit; 3 hits on the gun carriage.
3. Grazed in front of the screen which intercepted the segments.
4. Hit the screen 7 feet 10 inches from the ground; 4 of the gun detachment hit; the screen was removed and the firing carried on against the gun.

The screens were removed and the firing carried on against the guns.

5. Grazed behind the limber and burst.
6. Hit No. 1 at the gun and burst; 5 of the gun detachment struck; 8 hits on the limber.
7. Grazed 7 yards in rear of the gun; 3 of the gun detachment struck; 14 hits on the limber; a large hole through right limber box.
8. Grazed 7 yards in rear of the gun; 4 of the gun detachment hit; 12 hits on limber; left limber box knocked away and a large fragment through both sides.
9. Grazed 17 yards in front of the gun; 6 of the gun detachment hit; 2 hits on carriage; 1 hit on limber.

## EFFECT AGAINST ROPE MANTLETS.

## SEGMENT SHELL.

*June 3, 1864.*

RANGE, 400 yards.

The mantlets consisted of four plies of 4-inch rope frapped together with spun yarn in the usual manner.

A screen 2 inches thick was placed 23 yards in front of the mantlet, to burst the 3 first rounds of shell.

Two 9-foot targets 6 yards in rear of the mantlet.

- No. 1. Burst 17 yards in front of mantlet.  
10 hits on mantlet.  
1 through the mantlet.  
1 hit on target.

- No. 2. Burst 17 yards in front of mantlet.  
4 hits on mantlet.  
Nil through the mantlet.  
Nil on target.

- No. 3. Burst 19 yards in front of mantlet.  
1 hit on mantlet.  
Nil through the mantlet.  
3 hit the target.

- No. 4. Burst on passing through the mantle the screen having been removed.  
77 hits on the target.

- No. 5. Passed through the mantlet, and burst.  
123 hits on the target.  
One shell burst at the muzzle.

# DESTRUCTIVE EFFECT OF SEGMENT SHELL, USED AS COMMON CASE.

May 5, 1864.

RANGE, 450 yards.

The target consisted of six lines of 2-inch deal boards, 9 × 54 feet front, 5 yards interval.

Five rounds were fired.

Time and percussion fuzes used.

| Line of Targets. | No. of Target. | Through. | Struck. | Remarks.               |
|------------------|----------------|----------|---------|------------------------|
| 1st line -       | 1              | 0        | 0       |                        |
|                  | 2              | 1        | 0       |                        |
|                  | 3              | 2        | 0       |                        |
|                  | 4              | 1        | 0       |                        |
|                  | 5              | 1        | 0       |                        |
|                  | 6              | 0        | 0       |                        |
| 2nd line         | 1              | 0        | 0       |                        |
|                  | 2              | 1        | 4       | in. Ragged hole 10 × 9 |
|                  | 3              | 14       | 10      | " 14 × 12              |
|                  | 4              | 3        | 1       |                        |
|                  | 5              | 61       | 51      | " 15 × 5               |
|                  | 6              | 0        | 0       |                        |
| 3rd line         | 1              | 0        | 0       |                        |
|                  | 2              | 80       | 74      |                        |
|                  | 3              | 40       | 57      |                        |
|                  | 4              | 29       | 21      |                        |
|                  | 5              | 60       | 33      |                        |
|                  | 6              | 0        | 1       |                        |
| 4th line -       | 1              | 0        | 0       |                        |
|                  | 2              | 35       | 51      |                        |
|                  | 3              | 66       | 41      |                        |
|                  | 4              | 44       | 29      |                        |
|                  | 5              | 34       | 83      |                        |
|                  | 6              | 0        | 2       |                        |
| 5th line -       | 1              | 0        | 1       |                        |
|                  | 2              | 11       | 21      |                        |
|                  | 3              | 44       | 65      |                        |
|                  | 4              | 24       | 25      |                        |
|                  | 5              | 24       | 45      |                        |
|                  | 6              | 0        | 2       |                        |
| 6th line -       | 1              | 0        | 0       |                        |
|                  | 2              | 5        | 8       |                        |
|                  | 3              | 4        | 24      |                        |
|                  | 4              | 5        | 20      |                        |
|                  | 5              | 2        | 11      |                        |
|                  | 6              | 0        | 2       |                        |

May 6, 1864.

RANGE, 450 yards.

Five rounds against the same six lines of targets.

The record taken of the number of men that would have been struck had the targets been replaced by men :—

|            |   |   |        |
|------------|---|---|--------|
| 1st line - | - | - | 3 men. |
| 2nd „ -    | - | - | 7 „    |
| 3rd „ -    | - | - | 25 „   |
| 4th „ -    | - | - | 32 „   |
| 5th „ -    | - | - | 24 „   |
| 6th „ -    | - | - | 17 „   |

May 9, 1864.

RANGE, 300 yards. At a single line of targets 72 feet face, to represent men :—

|          |   |   |        |
|----------|---|---|--------|
| 2 rounds | - | - | 6 men. |
| 3 „      | - | - | 11 „   |

RANGE, 200 yards. At the same targets.

|          |   |   |        |
|----------|---|---|--------|
| 2 rounds | - | - | 3 men. |
| 3 „      | - | - | 1 „    |

RANGE, 100 yards. At same line of targets.

|          |   |   |         |
|----------|---|---|---------|
| 2 rounds | - | - | 16 men. |
| 3 „      | - | - | 20 „    |

RANGE, 50 yards. At same line of targets.

|          |   |   |         |
|----------|---|---|---------|
| 2 rounds | - | - | 11 men. |
| 3 „      | - | - | 17 „    |



(LIEUT. REEVES') COMMON CASE.

October 17, 1864.

The target consisted of 2-inch deal, area  $9 \times 54$  feet.

| RANGE, 350 yards. |   |          |         |         | RANGE, 250 yards. |   |          |         |         |
|-------------------|---|----------|---------|---------|-------------------|---|----------|---------|---------|
| —                 |   | Through. | Lodged. | Struck. | —                 |   | Through. | Lodged. | Struck. |
| 1st Round.        |   |          |         |         | 1st Round.        |   |          |         |         |
| 1 target -        | - | 0        | 0       | 0       | 1 target -        | - | 0        | 0       | 2       |
| 2 " -             | - | 1        | 0       | 0       | 2 " -             | - | 1        | 1       | 0       |
| 3 " -             | - | 0        | 2       | 0       | 3 " -             | - | 1        | 0       | 0       |
| 4 " -             | - | 1        | 0       | 0       | 4 " -             | - | 4        | 0       | 0       |
| 5 " -             | - | 0        | 0       | 0       | 5 " -             | - | 1        | 0       | 0       |
| 6 " -             | - | 0        | 0       | 1       | 6 " -             | - | 1        | 0       | 0       |
| 2nd Round.        |   |          |         |         | 2nd Round.        |   |          |         |         |
| 1 target -        | - | 1        | 0       | 0       | 1 target -        | - | 1        | 0       | 0       |
| 2 " -             | - | 0        | 0       | 0       | 2 " -             | - | 0        | 0       | 1       |
| 3 " -             | - | 1        | 0       | 0       | 3 " -             | - | 1        | 0       | 0       |
| 4 " -             | - | 1        | 0       | 0       | 4 " -             | - | 2        | 0       | 0       |
| 5 " -             | - | 0        | 1       | 1       | 5 " -             | - | 1        | 0       | 0       |
| 6 " -             | - | 1        | 0       | 0       | 6 " -             | - | 1        | 0       | 0       |
| 3rd Round.        |   |          |         |         | 3rd Round.        |   |          |         |         |
| 1 target -        | - | 0        | 0       | 0       | 1 target -        | - | 2        | 0       | 0       |
| 2 " -             | - | 1        | 1       | 1       | 2 " -             | - | 1        | 0       | 1       |
| 3 " -             | - | 0        | 0       | 1       | 3 " -             | - | 1        | 1       | 0       |
| 4 " -             | - | 0        | 0       | 2       | 4 " -             | - | 5        | 0       | 0       |
| 5 " -             | - | 0        | 0       | 0       | 5 " -             | - | 0        | 0       | 0       |
| 6 " -             | - | 2        | 1       | 0       | 6 " -             | - | 1        | 0       | 0       |
| 4th Round.        |   |          |         |         | 4th Round.        |   |          |         |         |
| 1 target -        | - | 0        | 1       | 0       | 1 target -        | - | 2        | 0       | 0       |
| 2 " -             | - | 1        | 0       | 0       | 2 " -             | - | 2        | 0       | 0       |
| 3 " -             | - | 1        | 1       | 0       | 3 " -             | - | 1        | 0       | 0       |
| 4 " -             | - | 0        | 0       | 0       | 4 " -             | - | 0        | 1       | 0       |
| 5 " -             | - | 0        | 2       | 0       | 5 " -             | - | 2        | 0       | 0       |
| 6 " -             | - | 1        | 0       | 0       | 6 " -             | - | 0        | 0       | 0       |
| 5th Round.        |   |          |         |         | 5th Round.        |   |          |         |         |
| 1 target -        | - | 1        | 2       | 0       | 1 target -        | - | 1        | 0       | 0       |
| 2 " -             | - | 1        | 1       | 0       | 2 " -             | - | 1        | 1       | 0       |
| 3 " -             | - | 0        | 1       | 1       | 3 " -             | - | 0        | 0       | 1       |
| 4 " -             | - | 0        | 0       | 0       | 4 " -             | - | 0        | 0       | 0       |
| 5 " -             | - | 1        | 0       | 0       | 5 " -             | - | 1        | 0       | 0       |
| 6 " -             | - | 0        | 0       | 0       | 6 " -             | - | 0        | 0       | 0       |

(LIEUT. REEVES') COMMON CASE—*continued.*

RANGE, 200 yards.

| —            | Through. | Lodged. | Struck. |
|--------------|----------|---------|---------|
| 1st Round.   |          |         |         |
| 1 target - - | 1        | 0       | 0       |
| 2 " - -      | 0        | 0       | 1       |
| 3 " - -      | 1        | 1       | 0       |
| 4 " - -      | 3        | 0       | 0       |
| 5 " - -      | 2        | 0       | 0       |
| 6 " - -      | 0        | 0       | 0       |

2nd Round.

|              |   |   |   |
|--------------|---|---|---|
| 1 target - - | 1 | 0 | 0 |
| 2 " - -      | 0 | 0 | 0 |
| 3 " - -      | 2 | 0 | 0 |
| 4 " - -      | 3 | 0 | 0 |
| 5 " - -      | 1 | 0 | 0 |
| 6 " - -      | 0 | 0 | 0 |

3rd Round.

|              |   |   |   |
|--------------|---|---|---|
| 1 target - - | 1 | 0 | 0 |
| 2 " - -      | 2 | 0 | 0 |
| 3 " - -      | 2 | 0 | 0 |
| 4 " - -      | 6 | 0 | 0 |
| 5 " - -      | 2 | 0 | 0 |
| 6 " - -      | 1 | 0 | 0 |

4th Round.

|              |   |   |   |
|--------------|---|---|---|
| 1 target - - | 3 | 0 | 0 |
| 2 " - -      | 2 | 0 | 1 |
| 3 " - -      | 6 | 0 | 2 |
| 4 " - -      | 1 | 0 | 0 |
| 5 " - -      | 0 | 0 | 0 |
| 6 " - -      | 6 | 1 | 0 |

5th Round.

|              |   |   |   |
|--------------|---|---|---|
| 1 target - - | 0 | 0 | 0 |
| 2 " - -      | 3 | 0 | 0 |
| 3 " - -      | 2 | 0 | 0 |
| 4 " - -      | 1 | 0 | 0 |
| 5 " - -      | 0 | 0 | 0 |
| 6 " - -      | 0 | 0 | 0 |

RANGE, 150 yards.

| —            | Through. | Lodged. | Struck. |
|--------------|----------|---------|---------|
| 1st Round.   |          |         |         |
| 1 target - - | 3        | 0       | 0       |
| 2 " - -      | 1        | 0       | 0       |
| 3 " - -      | 3        | 0       | 1       |
| 4 " - -      | 6        | 1       | 1       |
| 5 " - -      | 0        | 1       | 0       |
| 6 " - -      | 0        | 0       | 0       |

2nd Round.

|              |   |   |   |
|--------------|---|---|---|
| 1 target - - | 0 | 0 | 1 |
| 2 " - -      | 1 | 0 | 0 |
| 3 " - -      | 1 | 0 | 0 |
| 4 " - -      | 4 | 0 | 0 |
| 5 " - -      | 6 | 0 | 0 |
| 6 " - -      | 3 | 0 | 0 |

3rd Round.

|              |   |   |   |
|--------------|---|---|---|
| 1 target - - | 3 | 0 | 0 |
| 2 " - -      | 0 | 0 | 0 |
| 3 " - -      | 2 | 0 | 0 |
| 4 " - -      | 4 | 0 | 0 |
| 5 " - -      | 3 | 0 | 1 |
| 6 " - -      | 5 | 0 | 0 |

4th Round.

|              |   |   |   |
|--------------|---|---|---|
| 1 target - - | 3 | 0 | 1 |
| 2 " - -      | 2 | 0 | 0 |
| 3 " - -      | 7 | 0 | 1 |
| 4 " - -      | 8 | 0 | 0 |
| 5 " - -      | 6 | 0 | 0 |
| 6 " - -      | 0 | 1 | 1 |

5th Round.

|              |   |   |   |
|--------------|---|---|---|
| 1 target - - | 1 | 0 | 0 |
| 2 " - -      | 4 | 0 | 0 |
| 3 " - -      | 4 | 1 | 0 |
| 4 " - -      | 3 | 0 | 1 |
| 5 " - -      | 3 | 0 | 0 |
| 6 " - -      | 0 | 0 | 0 |

RANGE, 50 yards.

| —            | Through. | Lodged. | Struck. |
|--------------|----------|---------|---------|
| 1st Round.   |          |         |         |
| 1 target - - | 0        | 0       | 0       |
| 2 " - -      | 0        | 0       | 0       |
| 3 " - -      | 13       | 0       | 0       |
| 4 " - -      | 19       | 0       | 2       |
| 5 " - -      | 14       | 0       | 0       |
| 6 " - -      | 0        | 0       | 0       |

2nd Round.

|              |    |   |   |
|--------------|----|---|---|
| 1 target - - | 0  | 0 | 0 |
| 2 " - -      | 0  | 0 | 0 |
| 3 " - -      | 12 | 0 | 0 |
| 4 " - -      | 23 | 1 | 1 |
| 5 " - -      | 14 | 0 | 0 |
| 6 " - -      | 0  | 0 | 0 |

3rd Round.

|              |    |   |   |
|--------------|----|---|---|
| 1 target - - | 0  | 0 | 0 |
| 2 " - -      | 0  | 0 | 0 |
| 3 " - -      | 3  | 1 | 1 |
| 4 " - -      | 69 | 0 | 0 |
| 5 " - -      | 0  | 0 | 0 |
| 6 " - -      | 0  | 0 | 0 |

| —            | Through. | Lodged. | Struck. |
|--------------|----------|---------|---------|
| 4th Round.   |          |         |         |
| 1 target - - | 0        | 0       | 0       |
| 2 " - -      | 9        | 0       | 0       |
| 3 " - -      | 41       | 0       | 2       |
| 4 " - -      | 8        | 1       | 0       |
| 5 " - -      | 0        | 0       | 1       |
| 6 " - -      | 0        | 0       | 0       |

5th Round.

|              |    |   |   |
|--------------|----|---|---|
| 1 target - - | 3  | 0 | 0 |
| 2 " - -      | 26 | 0 | 1 |
| 3 " - -      | 15 | 0 | 1 |
| 4 " - -      | 5  | 0 | 1 |
| 5 " - -      | 0  | 0 | 0 |
| 6 " - -      | 0  | 0 | 0 |

# DESTRUCTIVE EFFECT OF SEGMENT SHELL AGAINST TARGETS REPRESENTING TROOPS IN LINE AND COLUMN.

May 30 and 31, 1864.

RANGE, 600 yards.

The shells were fired at a screen 2 inches thick, placed in front of the targets, so as to insure the shells bursting 25 yards in front.

The targets consisted of three 9-foot targets 2 inches thick.

The shells struck the screen from 3 to 6 feet above the ground.

Percussion fuze used throughout.

| —                                     | —        | Through. | Lodged. | Struck. |
|---------------------------------------|----------|----------|---------|---------|
| Struck 3 ft. above the ground.        | 1 target | 10       | 4       | 1       |
|                                       | 2 "      | 13       | 6       | 0       |
|                                       | 3 "      | 8        | 3       | 1       |
| Struck 5 ft. 8½ in. above the ground. | 1 target | 11       | 1       | 2       |
|                                       | 2 "      | 13       | 2       | 2       |
|                                       | 3 "      | 10       | 6       | 2       |
| Struck 5 ft. 6 in. above the ground.  | 1 target | 9        | 4       | 2       |
|                                       | 2 "      | 12       | 1       | 2       |
|                                       | 3 "      | 6        | 3       | 3       |
| Struck 5 ft. 8 in. above the ground.  | 1 target | 13       | 2       | 1       |
|                                       | 2 "      | 16       | 4       | 0       |
|                                       | 3 "      | 7        | 1       | 4       |
| Struck 3 ft. above the ground.        | 1 target | 8        | 2       | 0       |
|                                       | 2 "      | 10       | 0       | 2       |
|                                       | 3 "      | 9        | 4       | 2       |

The screen was placed in front of the targets, so that the shells should burst 50 yards in front.

The shell struck from 4 to 7 feet from the ground.

| —                                    | —        | Through. | Lodged. | Struck. |
|--------------------------------------|----------|----------|---------|---------|
| Struck 6 ft. above the ground.       | 1 target | 2        | 0       | 0       |
|                                      | 2 "      | 3        | 1       | 0       |
|                                      | 3 "      | 3        | 0       | 2       |
| Struck 7 ft. above the ground.       | 1 target | 0        | 0       | 1       |
|                                      | 2 "      | 2        | 0       | 0       |
|                                      | 3 "      | 5        | 1       | 2       |
|                                      | 4 "      | 5        | 2       | 0       |
|                                      | 5 "      | 3        | 3       | 2       |
|                                      | 6 "      | 3        | 1       | 0       |
| Struck 6 ft. 2 in. above the ground. | 1 target | 3        | 2       | 0       |
|                                      | 2 "      | 2        | 2       | 1       |
|                                      | 3 "      | 3        | 1       | 0       |
|                                      | 4 "      | 5        | 2       | 0       |
|                                      | 5 "      | 4        | 0       | 0       |
|                                      | 6 "      | 0        | 2       | 0       |
| Struck 6 ft. 4 in. above the ground. | 1 target | 3        | 0       | 0       |
|                                      | 2 "      | 2        | 2       | 0       |
|                                      | 3 "      | 7        | 0       | 0       |
|                                      | 4 "      | 2        | 0       | 2       |
|                                      | 5 "      | 7        | 1       | 0       |
|                                      | 6 "      | 6        | 0       | 0       |
| Struck 6 ft. 4 in. above the ground. | 1 target | 2        | 0       | 0       |
|                                      | 2 "      | 3        | 1       | 0       |
|                                      | 3 "      | 3        | 0       | 0       |
|                                      | 4 "      | 3        | 2       | 0       |
|                                      | 5 "      | 0        | 0       | 0       |
|                                      | 6 "      | 8        | 2       | 0       |

The shells struck from 3 feet to the ground.

| —                                    | —        | Through. | Lodged. | Struck. |
|--------------------------------------|----------|----------|---------|---------|
| Struck 3 ft. above the ground.       | 1 target | 19       | 1       | 3       |
|                                      | 2 "      | 12       | 3       | 0       |
|                                      | 3 "      | 14       | 2       | 0       |
| Struck 2 ft. 3 in. above the ground. | 1 target | 0        | 1       | 0       |
|                                      | 2 "      | 70       | 21      | 17      |
|                                      | 3 "      | 11       | 1       | 1       |
| Struck 1 ft. 8 in. above the ground. | 1 target | 17       | 3       | 1       |
|                                      | 2 "      | 14       | 3       | 2       |
|                                      | 3 "      | 9        | 4       | 3       |
| Struck 2 ft. 6 in. above the ground. | 1 target | 8        | 2       | 0       |
|                                      | 2 "      | 5        | 3       | 3       |
|                                      | 3 "      | 11       | 2       | 3       |
| Struck 2 ft. 6 in. above the ground. | 1 target | 17       | 2       | 0       |
|                                      | 2 "      | 9        | 1       | 0       |
|                                      | 3 "      | 17       | 1       | 0       |

Shells struck from 4 feet to the ground.

| —                                     | —        | Through. | Lodged. | Struck. |
|---------------------------------------|----------|----------|---------|---------|
| Shell struck 18 in. above the ground. | 1 target | 8        | 0       | 0       |
|                                       | 2 "      | 7        | 2       | 0       |
|                                       | 3 "      | 1        | 0       | 0       |
| Struck 2 ft. 6 in. above the ground.  | 1 target | 0        | 0       | 2       |
|                                       | 2 "      | 4        | 5       | 0       |
|                                       | 3 "      | 0        | 0       | 0       |
| Struck 2 ft. above the ground.        | 1 target | 2        | 0       | 0       |
|                                       | 2 "      | 5        | 0       | 0       |
|                                       | 3 "      | 2        | 2       | 0       |
| Struck 3 ft. 6 in. above the ground.  | 1 target | 2        | 2       | 0       |
|                                       | 2 "      | 6        | 1       | 1       |
|                                       | 3 "      | 5        | 2       | 0       |
| Struck 3 ft. 11 in. above the ground. | 1 target | 2        | 0       | 0       |
|                                       | 2 "      | 5        | 1       | 0       |
|                                       | 3 "      | 4        | 1       | 2       |
|                                       | 4 "      | 1        | 0       | 1       |
|                                       | 5 "      | 1        | 0       | 0       |
|                                       | 6 "      | 7        | 0       | 0       |

## SEGMENT SHELL—continued.

June 1, 1864.

## 12-POUNDER MUZZLE-LOADING ARMSTRONG.

RANGE, 600 yards.

The shells fired at a screen placed so as to burst them 100 yards in front of targets.

The shells struck the screen from 10 to 7 feet from the ground.

The shells struck from 7 feet to the ground.

| —                                    | —        | Through. | Lodged. | Struck. |
|--------------------------------------|----------|----------|---------|---------|
| Struck 7 ft. above the ground.       | 1 target | 0        | 0       | 1       |
|                                      | 2 "      | 1        | 2       | 2       |
|                                      | 3 "      | 0        | 1       | 0       |
|                                      | 4 "      | 0        | 0       | 1       |
|                                      | 5 "      | 1        | 2       | 5       |
|                                      | 6 "      | 1        | 3       | 0       |
|                                      | 7 "      | 0        | 0       | 0       |
|                                      | 8 "      | 0        | 1       | 2       |
| Struck 8 ft. 2 in. above the ground. | 1 target | 0        | 0       | 0       |
|                                      | 2 "      | 0        | 1       | 0       |
|                                      | 3 "      | 0        | 0       | 0       |
|                                      | 4 "      | 1        | 1       | 2       |
|                                      | 5 "      | 0        | 2       | 0       |
|                                      | 6 "      | 0        | 1       | 2       |
|                                      | 7 "      | 0        | 1       | 1       |
|                                      | 8 "      | 1        | 2       | 0       |
| Struck 8 ft. 4 in. above the ground. | 1 target | 2        | 0       | 1       |
|                                      | 2 "      | 0        | 0       | 0       |
|                                      | 3 "      | 0        | 0       | 1       |
|                                      | 4 "      | 0        | 0       | 4       |
|                                      | 5 "      | 2        | 1       | 3       |
|                                      | 6 "      | 1        | 0       | 0       |
|                                      | 7 "      | 0        | 0       | 0       |
|                                      | 8 "      | 0        | 0       | 0       |
| Struck 9 ft. 3 in. above the ground. | 1 target | 0        | 1       | 0       |
|                                      | 2 "      | 0        | 1       | 0       |
|                                      | 3 "      | 0        | 0       | 0       |
|                                      | 4 "      | 0        | 2       | 0       |
|                                      | 5 "      | 1        | 2       | 0       |
|                                      | 6 "      | 0        | 2       | 1       |
|                                      | 7 "      | 0        | 1       | 1       |
|                                      | 8 "      | 1        | 3       | 0       |
| Struck 7 ft. 9 in. above the ground. | 1 target | 0        | 1       | 2       |
|                                      | 2 "      | 1        | 1       | 0       |
|                                      | 3 "      | 0        | 2       | 0       |
|                                      | 4 "      | 0        | 0       | 0       |
|                                      | 5 "      | 2        | 1       | 3       |
|                                      | 6 "      | 0        | 1       | 0       |
|                                      | 7 "      | 0        | 1       | 2       |
|                                      | 8 "      | 0        | 0       | 1       |

One segment shell burst at the muzzle.

| —                                    | —        | Through. | Lodged. | Struck. |
|--------------------------------------|----------|----------|---------|---------|
| Struck 5 ft. 4 in. above the ground. | 1 target | 0        | 0       | 0       |
|                                      | 2 "      | 0        | 0       | 1       |
|                                      | 3 "      | 0        | 0       | 0       |
|                                      | 4 "      | 0        | 0       | 0       |
|                                      | 5 "      | 3        | 1       | 1       |
|                                      | 6 "      | 1        | 0       | 0       |
|                                      | 7 "      | 0        | 0       | 0       |
|                                      | 8 "      | 0        | 1       | 1       |
| Struck 4 ft. above the ground.       | 1 target | 0        | 0       | 0       |
|                                      | 2 "      | 0        | 1       | 1       |
|                                      | 3 "      | 0        | 0       | 1       |
|                                      | 4 "      | 0        | 1       | 0       |
|                                      | 5 "      | 2        | 1       | 1       |
|                                      | 6 "      | 0        | 1       | 0       |
|                                      | 7 "      | 0        | 0       | 1       |
|                                      | 8 "      | 0        | 1       | 0       |
| Struck 5 ft. 6 in. above the ground. | 1 target | 2        | 1       | 0       |
|                                      | 2 "      | 0        | 2       | 0       |
|                                      | 3 "      | 0        | 0       | 1       |
|                                      | 4 "      | 2        | 1       | 1       |
|                                      | 5 "      | 1        | 0       | 0       |
|                                      | 6 "      | 0        | 0       | 0       |
|                                      | 7 "      | 0        | 0       | 0       |
|                                      | 8 "      | 0        | 2       | 0       |
| Struck 5 ft. 7 in. above the ground. | 1 target | 4        | 1       | 0       |
|                                      | 2 "      | 1        | 1       | 1       |
|                                      | 3 "      | 1        | 0       | 0       |
|                                      | 4 "      | 1        | 2       | 1       |
|                                      | 5 "      | 2        | 2       | 0       |
|                                      | 6 "      | 0        | 1       | 1       |
|                                      | 7 "      | 1        | 1       | 0       |
|                                      | 8 "      | 4        | 2       | 1       |
| Struck 4 ft. 3 in. above the ground. | 1 target | 0        | 1       | 2       |
|                                      | 2 "      | 0        | 0       | 2       |
|                                      | 3 "      | 0        | 0       | 0       |
|                                      | 4 "      | 1        | 2       | 3       |
|                                      | 5 "      | 0        | 1       | 1       |
|                                      | 6 "      | 2        | 2       | 3       |
|                                      | 7 "      | 0        | 1       | 2       |
|                                      | 8 "      | 0        | 1       | 1       |

One segment shell burst at the muzzle.

SEGMENT SHELL—continued.

June 9, 1864.

RANGE, 800 yards.

The screen was placed 17 yards in front of the target, so as to insure the shells bursting 10 yards in front of the target.

| From ground to 5 feet above it.                  |          |          |         |         | From 5 ft. to 8 ft. 6 in. above the ground.      |          |          |         |         |
|--------------------------------------------------|----------|----------|---------|---------|--------------------------------------------------|----------|----------|---------|---------|
| —                                                | —        | Through. | Lodged. | Struck. | —                                                | —        | Through. | Lodged. | Struck. |
| Shell struck 2 ft.<br>3 in. above the<br>ground. | 1 target | 0        | 0       | 0       | Shell struck 8 ft.<br>4 in. above the<br>ground. | 1 target | 0        | 0       | 0       |
|                                                  | 2 "      | 0        | 0       | 0       |                                                  | 2 "      | 0        | 0       | 0       |
|                                                  | 3 "      | 5        | 0       | 0       |                                                  | 3 "      | 0        | 0       | 0       |
|                                                  | 4 "      | 31       | 8       | 3       |                                                  | 4 "      | 20       | 2       | 11      |
|                                                  | 5 "      | 28       | 5       | 3       |                                                  | 5 "      | 34       | 0       | 5       |
|                                                  | 6 "      | 8        | 1       | 2       |                                                  | 6 "      | 0        | 0       | 0       |
|                                                  | 7 "      | 0        | 0       | 0       |                                                  | 7 "      | 0        | 0       | 0       |
|                                                  | 8 "      | 0        | 0       | 0       |                                                  | 8 "      | 0        | 0       | 0       |
| Shell struck 2 ft.<br>8 in. above the<br>ground. | 1 target | 0        | 0       | 0       | Struck 7 ft. 4 in.<br>above the ground.          | 1 target | 0        | 0       | 0       |
|                                                  | 2 "      | 0        | 0       | 0       |                                                  | 2 "      | 0        | 0       | 0       |
|                                                  | 3 "      | 0        | 0       | 0       |                                                  | 3 "      | 1        | 0       | 1       |
|                                                  | 4 "      | 15       | 2       | 3       |                                                  | 4 "      | 29       | 2       | 2       |
|                                                  | 5 "      | 53       | 3       | 7       |                                                  | 5 "      | 17       | 2       | 4       |
|                                                  | 6 "      | 4        | 2       | 1       |                                                  | 6 "      | 0        | 0       | 0       |
|                                                  | 7 "      | 0        | 0       | 0       |                                                  | 7 "      | 0        | 0       | 0       |
|                                                  | 8 "      | 0        | 0       | 0       |                                                  | 8 "      | 0        | 0       | 0       |
| Shell struck 1 ft.<br>6 in. above the<br>ground. | 1 target | 0        | 0       | 0       | Struck 7 ft. above<br>the ground.                | 1 target | 0        | 0       | 0       |
|                                                  | 2 "      | 0        | 0       | 0       |                                                  | 2 "      | 0        | 0       | 0       |
|                                                  | 3 "      | 2        | 0       | 1       |                                                  | 3 "      | 2        | 0       | 0       |
|                                                  | 4 "      | 21       | 1       | 3       |                                                  | 4 "      | 32       | 3       | 5       |
|                                                  | 5 "      | 10       | 1       | 3       |                                                  | 5 "      | 16       | 2       | 3       |
|                                                  | 6 "      | 22       | 2       | 3       |                                                  | 6 "      | 0        | 0       | 1       |
|                                                  | 7 "      | 0        | 0       | 1       |                                                  | 7 "      | 0        | 0       | 0       |
|                                                  | 8 "      | 0        | 0       | 0       |                                                  | 8 "      | 0        | 0       | 0       |
| Shell struck 1 ft.<br>6 in. above the<br>ground. | 1 target | 0        | 0       | 0       | Struck 7 ft. above<br>the ground.                | 1 target | 0        | 0       | 0       |
|                                                  | 2 "      | 0        | 0       | 0       |                                                  | 2 "      | 0        | 0       | 0       |
|                                                  | 3 "      | 0        | 0       | 0       |                                                  | 3 "      | 0        | 0       | 0       |
|                                                  | 4 "      | 28       | 0       | 3       |                                                  | 4 "      | 15       | 5       | 4       |
|                                                  | 5 "      | 4        | 8       | 0       |                                                  | 5 "      | 16       | 0       | 3       |
|                                                  | 6 "      | 6        | 4       | 0       |                                                  | 6 "      | 7        | 1       | 1       |
|                                                  | 7 "      | 0        | 0       | 0       |                                                  | 7 "      | 0        | 0       | 0       |
|                                                  | 8 "      | 0        | 0       | 0       |                                                  | 8 "      | 0        | 0       | 0       |
| Shell struck 5 ft.<br>above the ground.          | 1 target | 0        | 0       | 0       | Struck 6 ft. 8 in.<br>above the ground.          | 1 target | 0        | 0       | 0       |
|                                                  | 2 "      | 0        | 0       | 0       |                                                  | 2 "      | 0        | 0       | 0       |
|                                                  | 3 "      | 1        | 0       | 0       |                                                  | 3 "      | 0        | 0       | 0       |
|                                                  | 4 "      | 27       | 13      | 4       |                                                  | 4 "      | 22       | 4       | 2       |
|                                                  | 5 "      | 31       | 8       | 2       |                                                  | 5 "      | 39       | 11      | 5       |
|                                                  | 6 "      | 0        | 0       | 0       |                                                  | 6 "      | 0        | 0       | 0       |
|                                                  | 7 "      | 0        | 0       | 0       |                                                  | 7 "      | 0        | 0       | 0       |
|                                                  | 8 "      | 3        | 0       | 0       |                                                  | 8 "      | 0        | 0       | 0       |

One shell burst at the muzzle.



## SEGMENT SHELL—continued.

June 10, 1864.

RANGE, 800 yards.

Shell to burst 25 yards in front of the targets.

From 5 to 9 feet.

From ground to 5 feet above.

| —                                    | —        | Through. | Lodged. | Struck. | —                                          | —        | Through. | Lodged. | Struck. |
|--------------------------------------|----------|----------|---------|---------|--------------------------------------------|----------|----------|---------|---------|
| Struck 7 ft. above the ground.       | 1 target | 0        | 0       | 0       | Shell struck 3 ft. 2 in. above the ground. | 1 target | 0        | 0       | 0       |
|                                      | 2 "      | 1        | 0       | 0       |                                            | 2 "      | 0        | 0       | 0       |
|                                      | 3 "      | 3        | 1       | 0       |                                            | 3 "      | 11       | 0       | 2       |
|                                      | 4 "      | 4        | 5       | 1       |                                            | 4 "      | 8        | 6       | 0       |
|                                      | 5 "      | 9        | 5       | 0       |                                            | 5 "      | 6        | 0       | 5       |
|                                      | 6 "      | 4        | 8       | 5       |                                            | 6 "      | 8        | 4       | 1       |
|                                      | 7 "      | 5        | 1       | 1       |                                            | 7 "      | 1        | 0       | 0       |
|                                      | 8 "      | 0        | 0       | 0       |                                            | 8 "      | 0        | 0       | 0       |
| Struck 7 ft. above the ground.       | 1 target | 6        | 1       | 0       | Shell struck 4 ft. above the ground.       | 1 target | 0        | 0       | 0       |
|                                      | 2 "      | 0        | 4       | 0       |                                            | 2 "      | 3        | 0       | 0       |
|                                      | 3 "      | 10       | 4       | 0       |                                            | 3 "      | 10       | 3       | 1       |
|                                      | 4 "      | 9        | 4       | 0       |                                            | 4 "      | 7        | 4       | 3       |
|                                      | 5 "      | 6        | 7       | 0       |                                            | 5 "      | 11       | 1       | 2       |
|                                      | 6 "      | 10       | 2       | 0       |                                            | 6 "      | 3        | 4       | 0       |
|                                      | 7 "      | 1        | 0       | 1       |                                            | 7 "      | 0        | 0       | 0       |
|                                      | 8 "      | 5        | 2       | 2       |                                            | 8 "      | 0        | 0       | 0       |
| Struck 7 ft. 4 in. above the ground. | 1 target | 0        | 0       | 0       | Struck 5 ft. above the ground.             | 1 target | 0        | 0       | 0       |
|                                      | 2 "      | 2        | 0       | 0       |                                            | 2 "      | 0        | 0       | 0       |
|                                      | 3 "      | 7        | 3       | 0       |                                            | 3 "      | 9        | 3       | 0       |
|                                      | 4 "      | 7        | 6       | 2       |                                            | 4 "      | 10       | 9       | 7       |
|                                      | 5 "      | 9        | 4       | 3       |                                            | 5 "      | 7        | 8       | 7       |
|                                      | 6 "      | 5        | 3       | 1       |                                            | 6 "      | 3        | 2       | 0       |
|                                      | 7 "      | 1        | 2       | 1       |                                            | 7 "      | 0        | 0       | 0       |
|                                      | 8 "      | 0        | 0       | 0       |                                            | 8 "      | 0        | 0       | 0       |
| Struck 5 ft. 4 in. above the ground. | 1 target | 0        | 0       | 0       | Struck 4 ft. 3 in. above the ground.       | 1 target | 0        | 0       | 0       |
|                                      | 2 "      | 0        | 0       | 0       |                                            | 2 "      | 0        | 0       | 0       |
|                                      | 3 "      | 9        | 4       | 2       |                                            | 3 "      | 0        | 0       | 0       |
|                                      | 4 "      | 6        | 1       | 1       |                                            | 4 "      | 8        | 6       | 2       |
|                                      | 5 "      | 10       | 7       | 3       |                                            | 5 "      | 3        | 2       | 1       |
|                                      | 6 "      | 9        | 0       | 0       |                                            | 6 "      | 8        | 4       | 3       |
|                                      | 7 "      | 0        | 0       | 0       |                                            | 7 "      | 6        | 6       | 0       |
|                                      | 8 "      | 0        | 0       | 0       |                                            | 8 "      | 0        | 1       | 0       |
| Struck 5 ft. 4 in. above the ground. | 1 target | 0        | 0       | 0       | Struck 6 in. above the ground.             | 1 target | 0        | 0       | 0       |
|                                      | 2 "      | 5        | 1       | 0       |                                            | 2 "      | 0        | 0       | 0       |
|                                      | 3 "      | 6        | 4       | 0       |                                            | 3 "      | 13       | 2       | 0       |
|                                      | 4 "      | 5        | 0       | 2       |                                            | 4 "      | 1        | 3       | 1       |
|                                      | 5 "      | 6        | 5       | 2       |                                            | 5 "      | 7        | 5       | 1       |
|                                      | 6 "      | 5        | 4       | 0       |                                            | 6 "      | 1        | 2       | 1       |
|                                      | 7 "      | 7        | 6       | 0       |                                            | 7 "      | 2        | 1       | 1       |
|                                      | 8 "      | 0        | 0       | 0       |                                            | 8 "      | 0        | 4       | 0       |

Two shells burst at the muzzle.

## SEGMENT SHELL—continued.

June 13, 1864.

RANGE, 800 yards.

The shells were burst 50 yards in front of the targets.

The shells to strike the screen from 6 to 10 feet from the ground.

From the ground to 6 feet.

|                                      |          | Through. | Lodged. | Struck. |                                      |          | Through. | Lodged. | Struck. |
|--------------------------------------|----------|----------|---------|---------|--------------------------------------|----------|----------|---------|---------|
| Struck 7 ft. 4 in. above the ground. | 1 target | 1        | 2       | 0       | Struck 3 ft. 8 in. above the ground. | 1 target | 4        | 3       | 0       |
|                                      | 2 "      | 6        | 3       | 0       |                                      | 2 "      | 1        | 3       | 2       |
|                                      | 3 "      | 1        | 3       | 0       |                                      | 3 "      | 1        | 2       | 0       |
|                                      | 4 "      | 3        | 4       | 0       |                                      | 4 "      | 4        | 3       | 2       |
|                                      | 5 "      | 1        | 1       | 0       |                                      | 5 "      | 0        | 2       | 1       |
|                                      | 6 "      | 1        | 3       | 0       |                                      | 6 "      | 5        | 3       | 1       |
|                                      | 7 "      | 0        | 1       | 1       |                                      | 7 "      | 3        | 2       | 2       |
|                                      | 8 "      | 0        | 0       | 0       |                                      | 8 "      | 0        | 1       | 0       |
| Struck 6 ft. 8 in. above the ground. | 1 target | 2        | 2       | 0       | Struck 5 ft. 8 in. above the ground. | 1 target | 0        | 3       | 1       |
|                                      | 2 "      | 1        | 4       | 0       |                                      | 2 "      | 0        | 2       | 1       |
|                                      | 3 "      | 1        | 3       | 1       |                                      | 3 "      | 0        | 3       | 1       |
|                                      | 4 "      | 2        | 3       | 3       |                                      | 4 "      | 4        | 5       | 0       |
|                                      | 5 "      | 2        | 3       | 0       |                                      | 5 "      | 2        | 1       | 1       |
|                                      | 6 "      | 0        | 2       | 0       |                                      | 6 "      | 1        | 1       | 0       |
|                                      | 7 "      | 0        | 3       | 0       |                                      | 7 "      | 3        | 0       | 1       |
|                                      | 8 "      | 7        | 0       | 0       |                                      | 8 "      | 1        | 2       | 0       |
| Struck 8 ft. above the ground.       | 1 target | 3        | 2       | 0       | Struck 5 ft. 4 in. above the ground. | 1 target | 1        | 0       | 0       |
|                                      | 2 "      | 4        | 1       | 0       |                                      | 2 "      | 1        | 1       | 1       |
|                                      | 3 "      | 0        | 0       | 0       |                                      | 3 "      | 2        | 1       | 1       |
|                                      | 4 "      | 0        | 0       | 1       |                                      | 4 "      | 0        | 1       | 0       |
|                                      | 5 "      | 1        | 1       | 1       |                                      | 5 "      | 3        | 4       | 6       |
|                                      | 6 "      | 1        | 1       | 2       |                                      | 6 "      | 2        | 1       | 0       |
|                                      | 7 "      | 5        | 2       | 4       |                                      | 7 "      | 0        | 0       | 3       |
|                                      | 8 "      | 3        | 2       | 0       |                                      | 8 "      | 0        | 1       | 0       |
| Struck 8 ft. above the ground.       | 1 target | 2        | 2       | 2       | Struck 4 ft. 6 in. above the ground. | 1 target | 2        | 0       | 1       |
|                                      | 2 "      | 0        | 2       | 1       |                                      | 2 "      | 1        | 0       | 0       |
|                                      | 3 "      | 0        | 0       | 0       |                                      | 3 "      | 0        | 1       | 1       |
|                                      | 4 "      | 3        | 4       | 2       |                                      | 4 "      | 2        | 1       | 0       |
|                                      | 5 "      | 1        | 5       | 2       |                                      | 5 "      | 7        | 2       | 3       |
|                                      | 6 "      | 2        | 3       | 1       |                                      | 6 "      | 4        | 2       | 0       |
|                                      | 7 "      | 2        | 1       | 0       |                                      | 7 "      | 5        | 2       | 1       |
|                                      | 8 "      | 1        | 0       | 0       |                                      | 8 "      | 1        | 2       | 1       |
| Struck 7 ft. above the ground.       | 1 target | 2        | 1       | 0       | Struck 1 ft. 8 in. above the ground. | 1 target | 3        | 4       | 2       |
|                                      | 2 "      | 4        | 2       | 0       |                                      | 2 "      | 2        | 3       | 0       |
|                                      | 3 "      | 0        | 3       | 0       |                                      | 3 "      | 3        | 3       | 4       |
|                                      | 4 "      | 2        | 3       | 2       |                                      | 4 "      | 4        | 2       | 2       |
|                                      | 5 "      | 3        | 2       | 0       |                                      | 5 "      | 3        | 2       | 2       |
|                                      | 6 "      | 0        | 3       | 0       |                                      | 6 "      | 6        | 2       | 4       |
|                                      | 7 "      | 5        | 4       | 0       |                                      | 7 "      | 5        | 4       | 4       |
|                                      | 8 "      | 2        | 1       | 0       |                                      | 8 "      | 1        | 0       | 0       |

## SEGMENT SHELL—continued.

June 14, 1864.

RANGE, 800 yards.

The shell to burst 100 yards in front of the target.

To strike the screen from 9 to 13 feet from the ground.

The shell to strike the screen from 9 feet to the ground.

|                                        |          | Through. | Lodged. | Struck. |                                       |          | Through. | Lodged. | Struck. |
|----------------------------------------|----------|----------|---------|---------|---------------------------------------|----------|----------|---------|---------|
| Struck 12 ft. 10 in. above the ground. | 1 target | 0        | 0       | 1       | Struck 2 ft. above the ground.        | 1 target | 0        | 1       | 1       |
|                                        | 2 "      | 1        | 1       | 1       |                                       | 2 "      | 2        | 2       | 0       |
|                                        | 3 "      | 1        | 1       | 0       |                                       | 3 "      | 3        | 2       | 1       |
|                                        | 4 "      | 0        | 3       | 1       |                                       | 4 "      | 0        | 3       | 1       |
|                                        | 5 "      | 3        | 1       | 1       |                                       | 5 "      | 2        | 1       | 0       |
|                                        | 6 "      | 0        | 4       | 1       |                                       | 6 "      | 0        | 0       | 0       |
|                                        | 7 "      | 0        | 1       | 1       |                                       | 7 "      | 0        | 1       | 0       |
|                                        | 8 "      | 0        | 3       | 1       |                                       | 8 "      | 0        | 2       | 0       |
| Struck 10 ft. 6 in. above the ground.  | 1 target | 0        | 0       | 1       | Struck 4 ft. 8 in. above the ground.  | 1 target | 0        | 0       | 0       |
|                                        | 2 "      | 0        | 1       | 0       |                                       | 2 "      | 0        | 0       | 0       |
|                                        | 3 "      | 0        | 1       | 1       |                                       | 3 "      | 2        | 1       | 2       |
|                                        | 4 "      | 0        | 3       | 0       |                                       | 4 "      | 0        | 1       | 3       |
|                                        | 5 "      | 0        | 1       | 0       |                                       | 5 "      | 0        | 0       | 4       |
|                                        | 6 "      | 0        | 3       | 0       |                                       | 6 "      | 0        | 0       | 0       |
|                                        | 7 "      | 0        | 0       | 1       |                                       | 7 "      | 0        | 2       | 0       |
|                                        | 8 "      | 1        | 1       | 0       |                                       | 8 "      | 0        | 1       | 1       |
| Struck 10 ft. 6 in. above the ground.  | 1 target | 2        | 2       | 0       | Struck 4 ft. 6 in. above the ground.  | 1 target | 0        | 0       | 0       |
|                                        | 2 "      | 0        | 1       | 0       |                                       | 2 "      | 0        | 1       | 0       |
|                                        | 3 "      | 0        | 3       | 0       |                                       | 3 "      | 0        | 1       | 1       |
|                                        | 4 "      | 0        | 0       | 0       |                                       | 4 "      | 1        | 1       | 1       |
|                                        | 5 "      | 1        | 0       | 2       |                                       | 5 "      | 0        | 0       | 0       |
|                                        | 6 "      | 0        | 3       | 1       |                                       | 6 "      | 0        | 1       | 0       |
|                                        | 7 "      | 0        | 2       | 0       |                                       | 7 "      | 0        | 0       | 1       |
|                                        | 8 "      | 0        | 2       | 0       |                                       | 8 "      | 0        | 0       | 0       |
| Struck 9 ft. 6 in. above the ground.   | 1 target | 0        | 1       | 0       | Struck 8 ft. 6 in. above the ground.  | 1 target | 0        | 2       | 0       |
|                                        | 2 "      | 0        | 1       | 0       |                                       | 2 "      | 0        | 0       | 0       |
|                                        | 3 "      | 3        | 0       | 0       |                                       | 3 "      | 0        | 1       | 0       |
|                                        | 4 "      | 1        | 0       | 0       |                                       | 4 "      | 0        | 3       | 0       |
|                                        | 5 "      | 1        | 2       | 2       |                                       | 5 "      | 1        | 1       | 1       |
|                                        | 6 "      | 0        | 2       | 1       |                                       | 6 "      | 0        | 2       | 1       |
|                                        | 7 "      | 0        | 0       | 0       |                                       | 7 "      | 0        | 2       | 1       |
|                                        | 8 "      | 0        | 1       | 1       |                                       | 8 "      | 0        | 0       | 0       |
| Struck 13 ft. above the ground.        | 1 target | 0        | 1       | 1       | Struck 10 ft. 6 in. above the ground. | 1 target | 0        | 0       | 1       |
|                                        | 2 "      | 0        | 2       | 0       |                                       | 2 "      | 0        | 1       | 0       |
|                                        | 3 "      | 0        | 0       | 0       |                                       | 3 "      | 0        | 1       | 1       |
|                                        | 4 "      | 0        | 2       | 0       |                                       | 4 "      | 0        | 3       | 0       |
|                                        | 5 "      | 0        | 1       | 5       |                                       | 5 "      | 0        | 1       | 0       |
|                                        | 6 "      | 0        | 1       | 0       |                                       | 6 "      | 0        | 3       | 0       |
|                                        | 7 "      | 0        | 2       | 0       |                                       | 7 "      | 0        | 0       | 1       |
|                                        | 8 "      | 0        | 0       | 0       |                                       | 8 "      | 1        | 1       | 0       |

SEGMENT SHELL—continued.

July 29, 1864.

RANGE, 1,300 yards.

The target consisted of three lines of 9-foot targets, five in each line, 6 yards between the lines. The shell to burst 10 yards in front of the first line of targets.

To strike the screen from 5 feet to ground.

To strike from 10 to 5 feet from the ground.

| ---                                              | —         | Through. | Lodged. | Struck. | ---                                    | —         | Through. | Lodged. | Struck. |
|--------------------------------------------------|-----------|----------|---------|---------|----------------------------------------|-----------|----------|---------|---------|
| Struck 1 ft. 6 in.<br>above the ground.          | 1st line. |          |         |         | Struck 10 ft. above<br>the ground.     | 1st line. |          |         |         |
|                                                  | 1 target  | 2        | 0       | 1       |                                        | 1 target  | 0        | 0       | 0       |
|                                                  | 2 "       | 11       | 5       | 4       |                                        | 2 "       | 0        | 0       | 0       |
|                                                  | 3 "       | 31       | 15      | 5       |                                        | 3 "       | 14       | 1       | 1       |
|                                                  | 4 "       | 3        | 6       | 0       |                                        | 4 "       | 9        | 2       | 2       |
|                                                  | 5 "       | 0        | 0       | 0       |                                        | 5 "       | 13       | 3       | 3       |
|                                                  | 2nd line. |          |         |         |                                        | 2nd line. |          |         |         |
|                                                  | 1 target  | 0        | 2       | 0       |                                        | 1 target  | 0        | 0       | 0       |
|                                                  | 2 "       | 1        | 5       | 0       |                                        | 2 "       | 0        | 1       | 0       |
|                                                  | 3 "       | 2        | 8       | 1       |                                        | 3 "       | 1        | 8       | 3       |
|                                                  | 4 "       | 2        | 11      | 3       |                                        | 4 "       | 3        | 5       | 0       |
|                                                  | 5 "       | 0        | 0       | 0       |                                        | 5 "       | 0        | 7       | 0       |
|                                                  | 3rd line. |          |         |         |                                        | 3rd line. |          |         |         |
|                                                  | 1 target  | 0        | 0       | 0       |                                        | 1 target  | 0        | 0       | 0       |
|                                                  | 2 "       | 0        | 0       | 0       |                                        | 2 "       | 0        | 0       | 0       |
| Struck 3 ft. 8 in.<br>above the ground.          | 1st line. |          |         |         | Struck 5 ft. 3 in.<br>from the ground. | 1st line. |          |         |         |
|                                                  | 1 target  | 11       | 7       | 1       |                                        | 1 target  | 2        | 1       | 4       |
|                                                  | 2 "       | 22       | 14      | 6       |                                        | 2 "       | 19       | 9       | 6       |
|                                                  | 3 "       | 19       | 10      | 2       |                                        | 3 "       | 16       | 8       | 7       |
|                                                  | 4 "       | 0        | 0       | 0       |                                        | 4 "       | 0        | 0       | 1       |
|                                                  | 5 "       | 0        | 0       | 0       |                                        | 5 "       | 0        | 0       | 0       |
|                                                  | 2nd line. |          |         |         |                                        | 2nd line. |          |         |         |
|                                                  | 1 target  | 1        | 8       | 5       |                                        | 1 target  | 0        | 0       | 0       |
|                                                  | 2 "       | 7        | 11      | 0       |                                        | 2 "       | 0        | 0       | 2       |
|                                                  | 3 "       | 0        | 8       | 2       |                                        | 3 "       | 1        | 3       | 5       |
|                                                  | 4 "       | 3        | 1       | 0       |                                        | 4 "       | 1        | 4       | 6       |
|                                                  | 5 "       | 0        | 1       | 0       |                                        | 5 "       | 0        | 1       | 0       |
|                                                  | 3rd line. |          |         |         |                                        | 3rd line. |          |         |         |
|                                                  | 1 target  | 1        | 0       | 0       |                                        | 1 target  | 0        | 0       | 0       |
|                                                  | 2 "       | 2        | 1       | 3       |                                        | 2 "       | 0        | 0       | 0       |
| Shell struck 1 ft.<br>6 in. above the<br>ground. | 1st line. |          |         |         | Struck 6 ft. above<br>the ground.      | 1st line. |          |         |         |
|                                                  | 1 target  | 0        | 0       | 0       |                                        | 1 target  | 0        | 0       | 0       |
|                                                  | 2 "       | 1        | 3       | 2       |                                        | 2 "       | 16       | 5       | 10      |
|                                                  | 3 "       | 14       | 12      | 5       |                                        | 3 "       | 11       | 8       | 4       |
|                                                  | 4 "       | 16       | 12      | 4       |                                        | 4 "       | 8        | 6       | 4       |
|                                                  | 5 "       | 5        | 6       | 0       |                                        | 5 "       | 0        | 0       | 0       |
|                                                  | 2nd line. |          |         |         |                                        | 2nd line. |          |         |         |
|                                                  | 1 target  | 1        | 0       | 0       |                                        | 1 target  | 0        | 0       | 0       |
|                                                  | 2 "       | 2        | 1       | 0       |                                        | 2 "       | 3        | 8       | 6       |
|                                                  | 3 "       | 3        | 5       | 1       |                                        | 3 "       | 1        | 1       | 5       |
|                                                  | 4 "       | 0        | 2       | 1       |                                        | 4 "       | 1        | 1       | 5       |
|                                                  | 5 "       | 0        | 6       | 5       |                                        | 5 "       | 0        | 4       | 0       |
|                                                  | 3rd line. |          |         |         |                                        | 3rd line. |          |         |         |
|                                                  | 1 target  | 0        | 1       | 1       |                                        | 1 target  | 0        | 0       | 0       |
|                                                  | 2 "       | 0        | 0       | 1       |                                        | 2 "       | 1        | 0       | 2       |
|                                                  | 3 "       | 0        | 0       | 0       |                                        | 3 "       | 2        | 1       | 1       |
|                                                  | 4 "       | 0        | 0       | 0       |                                        | 4 "       | 0        | 0       | 0       |
|                                                  | 5 "       | 0        | 0       | 0       |                                        | 5 "       | 0        | 0       | 1       |

SEGMENT SHELL—*continued.*

September 8, 1864.

RANGE, 1,300 yards.

Shell to burst 100 yards in front of target, from 9 feet to the ground.

|                                         |           | Through. | Lodged. | Struck. |                                         |           | Through. | Lodged. | Struck. |
|-----------------------------------------|-----------|----------|---------|---------|-----------------------------------------|-----------|----------|---------|---------|
| Struck 8 ft. above<br>the ground.       | 1st line. |          |         |         | Struck 8 ft. 7 in.<br>above the ground. | 1st line. |          |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                         | 1 target  | 1        | 2       | 2       |
|                                         | 2 "       | 0        | 3       | 0       |                                         | 2 "       | 0        | 0       | 0       |
|                                         | 3 "       | 1        | 0       | 0       |                                         | 3 "       | 0        | 1       | 0       |
|                                         | 4 "       | 1        | 1       | 3       |                                         | 4 "       | 0        | 0       | 2       |
|                                         | 5 "       | 1        | 1       | 2       |                                         | 5 "       | 1        | 0       | 0       |
|                                         | 2nd line. |          |         |         |                                         | 2nd line. |          |         |         |
|                                         | 1 target  | 0        | 1       | 0       |                                         | 1 target  | 0        | 1       | 1       |
|                                         | 2 "       | 0        | 0       | 0       |                                         | 2 "       | 0        | 0       | 0       |
|                                         | 3 "       | 0        | 0       | 0       |                                         | 3 "       | 0        | 0       | 0       |
|                                         | 4 "       | 1        | 0       | 0       |                                         | 4 "       | 1        | 0       | 0       |
|                                         | 5 "       | 0        | 0       | 0       |                                         | 5 "       | 0        | 0       | 0       |
|                                         | 3rd line. |          |         |         |                                         | 3rd line. |          |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                         | 1 target  | 0        | 0       | 0       |
|                                         | 2 "       | 0        | 0       | 0       |                                         | 2 "       | 0        | 0       | 0       |
| Struck 3 ft. 6 in.<br>above the ground. | 3 "       | 0        | 3       | 0       | Struck 2 ft. 2 in.<br>above the ground. | 3 "       | 0        | 0       | 0       |
|                                         | 4 "       | 0        | 0       | 1       |                                         | 4 "       | 0        | 0       | 0       |
|                                         | 5 "       | 0        | 1       | 0       |                                         | 5 "       | 0        | 0       | 1       |
|                                         | 1st line. |          |         |         |                                         | 1st line. |          |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                         | 1 target  | 1        | 2       | 1       |
|                                         | 2 "       | 3        | 2       | 1       |                                         | 2 "       | 0        | 2       | 0       |
|                                         | 3 "       | 0        | 2       | 2       |                                         | 3 "       | 0        | 1       | 2       |
|                                         | 4 "       | 1        | 1       | 0       |                                         | 4 "       | 0        | 2       | 0       |
|                                         | 5 "       | 0        | 1       | 0       |                                         | 5 "       | 0        | 2       | 1       |
|                                         | 2nd line. |          |         |         |                                         | 2nd line. |          |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                         | 1 target  | 0        | 0       | 0       |
|                                         | 2 "       | 0        | 0       | 0       |                                         | 2 "       | 0        | 0       | 0       |
|                                         | 3 "       | 0        | 2       | 3       |                                         | 3 "       | 1        | 0       | 0       |
|                                         | 4 "       | 0        | 0       | 0       |                                         | 4 "       | 0        | 0       | 0       |
|                                         | 5 "       | 0        | 0       | 0       |                                         | 5 "       | 0        | 0       | 0       |
|                                         | 3rd line. |          |         |         |                                         | 3rd line. |          |         |         |
|                                         | 1 target  | 0        | 0       | 0       |                                         | 1 target  | 0        | 0       | 0       |
|                                         | 2 "       | 0        | 0       | 0       |                                         | 2 "       | 0        | 0       | 0       |
|                                         | 3 "       | 0        | 0       | 0       |                                         | 3 "       | 1        | 0       | 1       |
|                                         | 4 "       | 0        | 0       | 0       |                                         | 4 "       | 0        | 1       | 0       |
|                                         | 5 "       | 0        | 0       | 0       |                                         | 5 "       | 0        | 0       | 1       |

|                                   |           | Through. | Lodged. | Struck. |
|-----------------------------------|-----------|----------|---------|---------|
| Struck 8 ft. above<br>the ground. | 1st line. |          |         |         |
|                                   | 1 target  | 0        | 0       | 1       |
|                                   | 2 "       | 0        | 0       | 1       |
|                                   | 3 "       | 0        | 2       | 1       |
|                                   | 4 "       | 0        | 0       | 1       |
|                                   | 5 "       | 0        | 2       | 1       |
|                                   | 2nd line. |          |         |         |
|                                   | 1 target  | 0        | 0       | 0       |
|                                   | 2 "       | 0        | 0       | 0       |
|                                   | 3 "       | 0        | 0       | 0       |
|                                   | 4 "       | 1        | 0       | 0       |
|                                   | 5 "       | 0        | 1       | 0       |
|                                   | 3rd line. |          |         |         |
|                                   | 1 target  | 0        | 0       | 0       |
|                                   | 2 "       | 0        | 0       | 0       |
|                                   | 3 "       | 0        | 0       | 0       |
|                                   | 4 "       | 0        | 0       | 0       |
|                                   | 5 "       | 0        | 0       | 0       |



SEGMENT SHELL—*continued.*

September 8, 1864.

RANGE, 1,300 yards.

Shell to burst 100 yards in front of target and to strike from 9 to 18 feet from the ground.

| —                                        | —         | Through. | Lodged. | Struck. | —                                        | —         | Through. | Lodged. | Struck. |
|------------------------------------------|-----------|----------|---------|---------|------------------------------------------|-----------|----------|---------|---------|
| Struck 11 ft. 6 in.<br>above the ground. | 1st line. |          |         |         | Struck 13 ft. 6 in.<br>above the ground. | 1st line. |          |         |         |
|                                          | 1 target  | 0        | 0       | 1       |                                          | 1 target  | 0        | 2       | 0       |
|                                          | 2 "       | 0        | 2       | 0       |                                          | 2 "       | 0        | 0       | 2       |
|                                          | 3 "       | 1        | 1       | 1       |                                          | 3 "       | 1        | 1       | 0       |
|                                          | 4 "       | 0        | 0       | 0       |                                          | 4 "       | 0        | 0       | 0       |
|                                          | 5 "       | 1        | 2       | 0       |                                          | 5 "       | 0        | 1       | 1       |
|                                          | 2nd line. |          |         |         |                                          | 2nd line. |          |         |         |
|                                          | 1 target  | 0        | 0       | 0       |                                          | 1 target  | 0        | 0       | 0       |
|                                          | 2 "       | 0        | 0       | 0       |                                          | 2 "       | 0        | 0       | 0       |
|                                          | 3 "       | 0        | 0       | 0       |                                          | 3 "       | 0        | 0       | 0       |
|                                          | 4 "       | 0        | 0       | 1       |                                          | 4 "       | 0        | 0       | 0       |
|                                          | 5 "       | 1        | 0       | 0       |                                          | 5 "       | 0        | 0       | 0       |
|                                          | 3rd line. |          |         |         |                                          | 3rd line. |          |         |         |
|                                          | 1 target  | 0        | 0       | 0       |                                          | 1 target  | 0        | 0       | 0       |
|                                          | 2 "       | 0        | 0       | 0       |                                          | 2 "       | 0        | 0       | 0       |
| Struck 12 ft. 6 in.<br>above the ground. | 3 "       | 0        | 0       | 0       | Struck 12 ft. 8 in.<br>above the ground. | 3 "       | 0        | 0       | 1       |
|                                          | 4 "       | 0        | 0       | 0       |                                          | 4 "       | 0        | 1       | 0       |
|                                          | 5 "       | 2        | 0       | 0       |                                          | 5 "       | 0        | 0       | 0       |
|                                          | 1st line. |          |         |         |                                          | 1st line. |          |         |         |
|                                          | 1 target  | 0        | 1       | 0       |                                          | 1 target  | 2        | 0       | 0       |
|                                          | 2 "       | 0        | 0       | 0       |                                          | 2 "       | 0        | 3       | 0       |
|                                          | 3 "       | 2        | 0       | 0       |                                          | 3 "       | 3        | 0       | 0       |
|                                          | 4 "       | 0        | 0       | 1       |                                          | 4 "       | 1        | 0       | 0       |
|                                          | 5 "       | 0        | 0       | 0       |                                          | 5 "       | 0        | 1       | 0       |
|                                          | 2nd line. |          |         |         |                                          | 2nd line. |          |         |         |
|                                          | 1 target  | 0        | 0       | 0       |                                          | 1 target  | 0        | 0       | 0       |
|                                          | 2 "       | 0        | 1       | 0       |                                          | 2 "       | 0        | 0       | 0       |
|                                          | 3 "       | 0        | 0       | 1       |                                          | 3 "       | 1        | 0       | 0       |
|                                          | 4 "       | 0        | 0       | 0       |                                          | 4 "       | 0        | 0       | 0       |
|                                          | 5 "       | 0        | 1       | 0       |                                          | 5 "       | 0        | 1       | 0       |
|                                          | 3rd line. |          |         |         |                                          | 3rd line. |          |         |         |
|                                          | 1 target  | 0        | 0       | 0       |                                          | 1 target  | 0        | 0       | 0       |
|                                          | 2 "       | 0        | 0       | 0       |                                          | 2 "       | 0        | 0       | 0       |
|                                          | 3 "       | 1        | 0       | 0       |                                          | 3 "       | 1        | 0       | 0       |
|                                          | 4 "       | 0        | 0       | 1       |                                          | 4 "       | 0        | 0       | 0       |
|                                          | 5 "       | 0        | 0       | 0       |                                          | 5 "       | 0        | 0       | 1       |

SEGMENT SHELL—*continued.*

September 13, 1864.

RANGE, 1,300 yards.

Segment shell with percussion fuzes, fired so as to strike the ground at different distances in front of the targets, and burst on graze.

The targets consisted of three lines of 2-inch deal targets, 9 × 9 feet, five in each line, 6 yards interval between the lines.

|                         |           | Through. | Lodged. | Struck. |
|-------------------------|-----------|----------|---------|---------|
| Struck 41 yards short.  | 1st line. |          |         |         |
|                         | 1 target  | 5        | 0       | 2       |
|                         | 2 "       | 9        | 1       | 0       |
|                         | 3 "       | 3        | 2       | 0       |
|                         | 4 "       | 2        | 0       | 0       |
|                         | 5 "       | 0        | 0       | 0       |
|                         | 2nd line. |          |         |         |
|                         | 1 target  | 0        | 1       | 0       |
|                         | 2 "       | 0        | 1       | 0       |
|                         | 3 "       | 1        | 0       | 0       |
|                         | 4 "       | 1        | 1       | 1       |
|                         | 5 "       | 0        | 0       | 1       |
|                         | 3rd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |
|                         | 2 "       | 0        | 0       | 0       |
|                         | 3 "       | 0        | 1       | 0       |
|                         | 4 "       | 0        | 0       | 0       |
|                         | 5 "       | 0        | 0       | 0       |
| Struck 27 yards short.  | 1st line. |          |         |         |
|                         | 1 target  | 16       | 3       | 3       |
|                         | 2 "       | 11       | 2       | 3       |
|                         | 3 "       | 0        | 0       | 0       |
|                         | 4 "       | 0        | 0       | 0       |
|                         | 5 "       | 0        | 0       | 0       |
|                         | 2nd line. |          |         |         |
|                         | 1 target  | 0        | 3       | 8       |
|                         | 2 "       | 3        | 10      | 5       |
|                         | 3 "       | 2        | 0       | 0       |
|                         | 4 "       | 0        | 0       | 1       |
|                         | 5 "       | 0        | 1       | 1       |
|                         | 3rd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |
|                         | 2 "       | 0        | 0       | 2       |
|                         | 3 "       | 0        | 0       | 0       |
|                         | 4 "       | 0        | 0       | 1       |
|                         | 5 "       | 0        | 0       | 0       |
| Struck 109 yards short. | 1st line. |          |         |         |
|                         | 1 target  | 0        | 1       | 0       |
|                         | 2 "       | 0        | 0       | 0       |
|                         | 3 "       | 0        | 1       | 0       |
|                         | 4 "       | 0        | 0       | 2       |
|                         | 5 "       | 1        | 0       | 1       |
|                         | 2nd line. |          |         |         |
|                         | 1 target  | 0        | 1       | 0       |
|                         | 2 "       | 0        | 0       | 0       |
|                         | 3 "       | 0        | 0       | 0       |
|                         | 4 "       | 0        | 0       | 0       |
|                         | 5 "       | 0        | 0       | 0       |
|                         | 3rd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |
|                         | 2 "       | 0        | 0       | 0       |
|                         | 3 "       | 0        | 0       | 1       |
|                         | 4 "       | 0        | 0       | 0       |
|                         | 5 "       | 0        | 0       | 0       |

|                        |           | Through. | Lodged. | Struck. |
|------------------------|-----------|----------|---------|---------|
| Struck 54 yards short. | 1st line. |          |         |         |
|                        | 1 target  | 1        | 1       | 0       |
|                        | 2 "       | 3        | 2       | 1       |
|                        | 3 "       | 3        | 0       | 0       |
|                        | 4 "       | 3        | 1       | 2       |
|                        | 5 "       | 0        | 1       | 0       |
|                        | 2nd line. |          |         |         |
|                        | 1 target  | 0        | 0       | 0       |
|                        | 2 "       | 0        | 1       | 3       |
|                        | 3 "       | 0        | 1       | 2       |
|                        | 4 "       | 0        | 0       | 1       |
|                        | 5 "       | 0        | 0       | 0       |
|                        | 3rd line. |          |         |         |
|                        | 1 target  | 0        | 0       | 0       |
|                        | 2 "       | 0        | 0       | 0       |
|                        | 3 "       | 0        | 0       | 0       |
|                        | 4 "       | 0        | 0       | 0       |
|                        | 5 "       | 0        | 0       | 0       |
| Struck 88 yards short. | 1st line. |          |         |         |
|                        | 1 target  | 0        | 0       | 1       |
|                        | 2 "       | 0        | 0       | 1       |
|                        | 3 "       | 0        | 0       | 1       |
|                        | 4 "       | 0        | 1       | 0       |
|                        | 5 "       | 0        | 0       | 0       |
|                        | 2nd line. |          |         |         |
|                        | 1 target  | 0        | 0       | 0       |
|                        | 2 "       | 0        | 0       | 0       |
|                        | 3 "       | 0        | 0       | 0       |
|                        | 4 "       | 0        | 0       | 0       |
|                        | 5 "       | 0        | 0       | 0       |
|                        | 3rd line. |          |         |         |
|                        | 1 target  | 0        | 0       | 0       |
|                        | 2 "       | 0        | 0       | 0       |
|                        | 3 "       | 0        | 0       | 0       |
|                        | 4 "       | 0        | 0       | 0       |
|                        | 5 "       | 0        | 0       | 0       |

September 14, 1864.

RANGE, 800 yards.

Segment shell with percussion fuzes fired to strike the ground at different distances in front of the targets, and burst on graze.

The target consisted of 7 deal targets 9' × 9' × 2".

|                        |          | Through. | Lodged. | Struck. |
|------------------------|----------|----------|---------|---------|
| Struck 26 yards short. | 1 target | 0        | 0       | 0       |
|                        | 2 "      | 1        | 0       | 0       |
|                        | 3 "      | 7        | 4       | 0       |
|                        | 4 "      | 6        | 3       | 0       |
|                        | 5 "      | 21       | 9       | 0       |
|                        | 6 "      | 6        | 0       | 0       |
|                        | 7 "      | 0        | 0       | 0       |
| Struck 27 yards short. | 1 target | 0        | 0       | 1       |
|                        | 2 "      | 12       | 3       | 0       |
|                        | 3 "      | 16       | 3       | 0       |
|                        | 4 "      | 10       | 3       | 1       |
|                        | 5 "      | 1        | 1       | 2       |
|                        | 6 "      | 1        | 0       | 0       |
|                        | 7 "      | 0        | 0       | 0       |
| Struck 22 yards short. | 1 target | 0        | 0       | 0       |
|                        | 2 "      | 0        | 0       | 0       |
|                        | 3 "      | 1        | 0       | 0       |
|                        | 4 "      | 17       | 3       | 4       |
|                        | 5 "      | 30       | 4       | 3       |
|                        | 6 "      | 1        | 1       | 0       |
|                        | 7 "      | 0        | 0       | 0       |

FUZES.

September 15, 1864.

The time fuze was set at 0.5 of inch, and the time of burning taken with stop clocks.

Elevation of gun 3°.

| Stop<br>Clocks. | 1st<br>Round. | 2nd<br>Round. | 3rd<br>Round. | 4th<br>Round. | 5th<br>Round. |
|-----------------|---------------|---------------|---------------|---------------|---------------|
| No. 1 -         | Sec.<br>1.1   | Sec.<br>1.2   | Sec.<br>1.2   | Sec.<br>1.3   | Sec.<br>1.3   |
| No. 2 -         | 1.0           | 1.1           | 1.1           | 1.3           | 1.2           |
| No. 3 -         | 1.2           | 1.2           | 1.1           | 1.2           | 1.2           |

Elevation of gun 4°.

| Stop<br>Clocks. | 1st<br>Round. | 2nd<br>Round. | 3rd<br>Round. | 4th<br>Round. | 5th<br>Round. |
|-----------------|---------------|---------------|---------------|---------------|---------------|
| No. 1 -         | Sec.<br>1.2   | Sec.<br>1.3   | Sec.<br>1.0   | Sec.<br>1.3   | Sec.<br>1.0   |
| No. 2 -         | 1.1           | 1.3           | 1.0           | 1.3           | 1.0           |
| No. 3 -         |               | 1.2           | 1.0           | 1.2           | 1.0           |

Elevation at 4°.

| Stop<br>Clocks. | 1st<br>Round. | 2nd<br>Round. | 3rd<br>Round. | 4th<br>Round. | 5th<br>Round. |
|-----------------|---------------|---------------|---------------|---------------|---------------|
| No. 1 -         | Sec.<br>1.0   | Sec.<br>1.3   | Sec.<br>1.5   | Sec.<br>1.1   | Sec.<br>1.2   |
| No. 2 -         | 1.0           | 1.2           | 1.4           | 1.0           | 1.2           |
| No. 3 -         | 1.0           | 1.2           | 1.5           | 1.2           | 1.1           |

Percussion fuzes fired to graze on the water.

|             | Eleva-<br>tion 0°. |        | Eleva-<br>tion 1°. |        | Eleva-<br>tion 2°. |        | Eleva-<br>tion 3°. |        | Eleva-<br>tion 4°. |        | Eleva-<br>tion 5°. |        | Eleva-<br>tion 6°. |        | Eleva-<br>tion 7°. |        |
|-------------|--------------------|--------|--------------------|--------|--------------------|--------|--------------------|--------|--------------------|--------|--------------------|--------|--------------------|--------|--------------------|--------|
|             | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. |
| 1st round - | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | 1      | -                  | 1      | -                  | 1      | 1                  | -      |
| 2nd round - | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      |

Time fuzes set at 1.25 of an inch.

Elevation of gun 5°.

| Stop<br>Clocks. | 1st<br>Round. | 2nd<br>Round. | 3rd<br>Round. | 4th<br>Round. | 5th<br>Round. |
|-----------------|---------------|---------------|---------------|---------------|---------------|
| No. 1 -         | Sec.<br>2.7   | Sec.<br>2.6   | Sec.<br>2.8   | Sec.<br>2.7   | Sec.<br>2.6   |
| No. 2 -         | 2.8           | 2.6           | 2.9           | 2.7           | 2.5           |
| No. 3 -         | 2.6           | 2.6           | 2.7           | 2.7           | 2.7           |

Time fuzes set to 3. inches.

Elevation of gun 6°.

| Stop<br>Clocks. | 1st<br>Round. | 2nd<br>Round. | 3rd<br>Round. | 4th<br>Round. | 5th<br>Round. |
|-----------------|---------------|---------------|---------------|---------------|---------------|
| No. 1 -         | Sec.<br>6.0   | Sec.<br>6.2   | Sec.<br>6.1   | Sec.<br>6.5   | Sec.<br>6.3   |
| No. 2 -         | 5.9           | 6.2           | 6.0           | 6.1           | 6.3           |
| No. 3 -         | 6.0           | 6.3           | 6.0           | 6.5           | 6.3           |

Time fuzes set to 1.75 inch.

Elevation of gun 6°.

| Stop<br>Clocks. | 1st<br>Round. | 2nd<br>Round. | 3rd<br>Round. | 4th<br>Round. | 5th<br>Round. |
|-----------------|---------------|---------------|---------------|---------------|---------------|
| No. 1 -         | Sec.<br>3.3   | Sec.<br>3.8   | Sec.<br>3.6   | Sec.<br>3.6   | Sec.<br>3.3   |
| No. 2 -         | 3.4           | 3.8           | 3.6           | 3.5           | 3.4           |
| No. 3 -         | 3.5           | 3.8           | 3.6           | 3.5           | 3.4           |

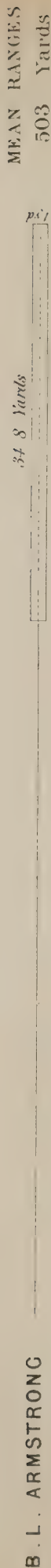
Percussion fuzes made to graze on sand.

|           | Eleva-<br>tion 0°. |        | Eleva-<br>tion 1°. |        | Eleva-<br>tion 2°. |        | Eleva-<br>tion 3°. |        | Eleva-<br>tion 4°. |        |
|-----------|--------------------|--------|--------------------|--------|--------------------|--------|--------------------|--------|--------------------|--------|
|           | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. | Good.              | Blind. |
| 1st round | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      |
| 2nd round | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      | 1                  | -      |

# 12 P<sup>R</sup> GUNS

## SOLID SHOT

0° by spirit level Axis 17 feet above the Plain  
 Obtained from 6 Rounds 4<sup>th</sup> April 1864.







# 12 P<sup>R</sup> GUNS SEGMENT AND SHRAPNELL SHELL

0° by spirit level, Axis 17 feet above the Plane  
 Obtained from 16 Rounds, 22<sup>nd</sup> Feb<sup>ry</sup> 1865.



Scale of 12 Yards to one Inch



# 12 PR GUNS

## SOLID SHOT

0° by spirit level Axis 17 feet above the Plain  
 Obtained from 18 Rounds 1<sup>st</sup> May 1864.

MEAN RANGES  
 465 Yards

30 Yards

B. L. ARMSTRONG

18.8 Yards

WHITWORTH

500

33 Yards

M. L. ARMSTRONG

511

Scale of 12 Yards to one Inch.



# 12 P<sub>R</sub> GUNS

## SOLID SHOT

1° by spirit level Axis 17 feet above the Plain  
 Obtained from 5 Rounds 4<sup>th</sup> April 1864.

| B. L. ARMSTRONG | 28. 4. Yards |     | MEAN RANGES |
|-----------------|--------------|-----|-------------|
|                 | 1st          | 2nd |             |
|                 |              |     | 867 Yards   |

| WHITWORTH | 34. 9. Yards |     | 914 |
|-----------|--------------|-----|-----|
|           | 1st          | 2nd |     |
|           |              |     |     |

| M. L. ARMSTRONG | 31. 7. Yards |     | 905 |
|-----------------|--------------|-----|-----|
|                 | 1st          | 2nd |     |
|                 |              |     |     |

Scale of 12 Yards to one Inch.





# 12 PR GUNS

## SOLID SHOT

1° by spirit level Axis 17 feet above the Plain  
 Obtained from 12 Rounds 5<sup>th</sup> April 1864.





# 12 P<sup>R</sup> GUNS

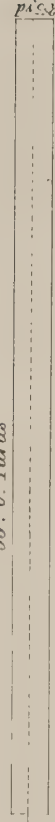
## SOLID SHOT

2° by spirit level Axis 17 feet above the Plain

Obtained from 18 Rounds 11<sup>th</sup> April 1864.

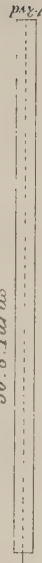
MEAN RANGES  
1185 Yards

55.0 Yards



B. L. ARMSTRONG

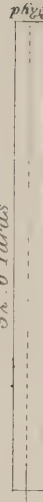
36.8 Yards



WHITWORTH

1283

33.6 Yards



M. L. ARMSTRONG

1265

Scale of 12 Yards to one Inch.



SOLID SHOT

Obtained from 18 Rounds 13<sup>th</sup> April 1864.

Scale of 12 Yards to one Inch.





# 12 PR GUNS.

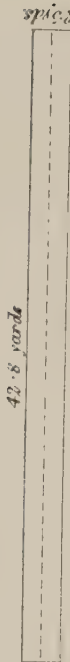
## SEGMENT AND SHRAPNEL SHELL.

3° by spirit, level Axis 17 feet above the Plane.

Obtained from 18 Rounds. 22<sup>nd</sup> Feb<sup>y</sup> 1865.

B. L. ARMSTRONG

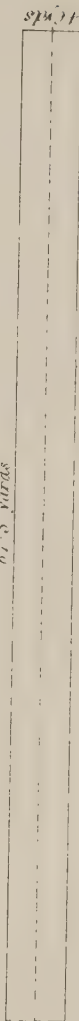
42.8 yards



MEAN RANGES  
1445 Yards

WHITWORTH

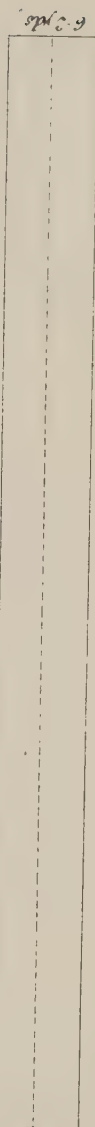
67.3 yards



1558

M. L. ARMSTRONG

74.0 yards



1607



# 12 PR GUNS

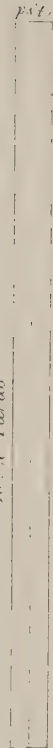
## SOLID SHOT

4° by spirit level, Axis 17 feet above the Plane

Obtained from 18 Rounds 14<sup>th</sup> April 1864.

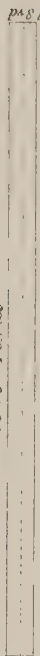
MEAN RANGES  
1770 Yards

50.3 Yards



B. L. ARMSTRONG

43.9 Yards



WHITWORTH

1892

44.5 Yards



M. L. ARMSTRONG

1923

Scale of 12 Yards to one Inch.



# 12 PR GUNS

## SOLID SHOT (After firing 2800 Rounds)

5° by spirit level Axis 17 feet above the Plain  
 Obtained from 20 Rounds 22<sup>th</sup> December 1864.

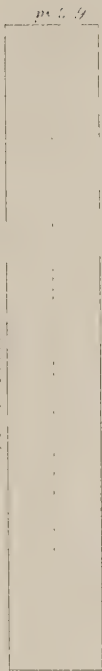
MEAN RANGES  
 1813 Yards

72 Yards



B. L. ARMSTRONG

44 1 Yards



WHITWORTH

2211

52 1 Yards



M. L. ARMSTRONG

1925

Scale of 12 Yards to one Inch.





# 12 PR GUNS

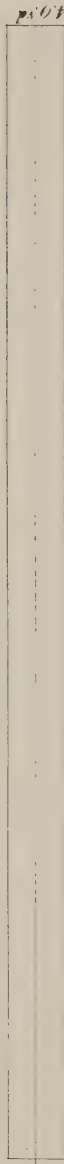
## SOLID SHOT

5° by spirit level Axis 17 feet above the Plain  
 Obtained from 18 Rounds 15<sup>th</sup> April 1864.

MEAN RANGES  
 2115 Yards

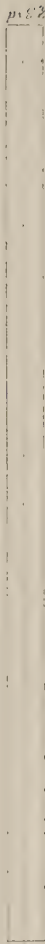
78.4 Yards

B. L. ARMSTRONG



63.6 Yards

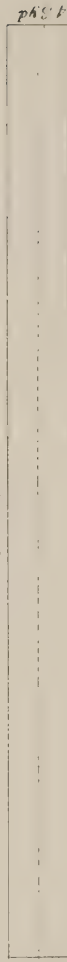
WHITWORTH



2330

64.5 Yards

M. L. ARMSTRONG



2230

Scale of 12 Yards to one Inch.



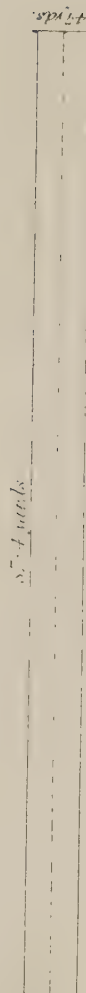
# 12 PR GUNS

## SEGMENT AND SHRAPNEL SHELL.

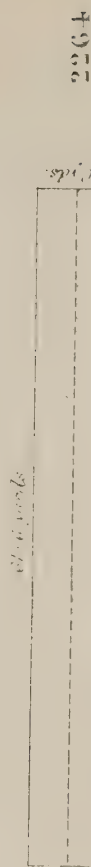
5° by spirit level Axis 17 feet above the Plane  
 Obtained from 17 Rounds 22<sup>nd</sup> Feb'y 1865.

MEAN RANGES  
 2080 Yards

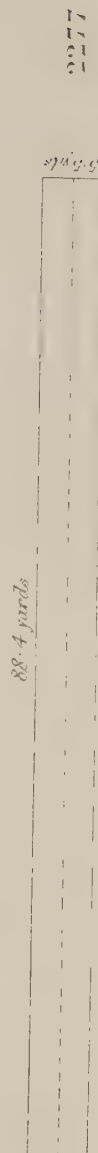
B. L. ARMSTRONG



WHITWORTH



M. L. ARMSTRONG



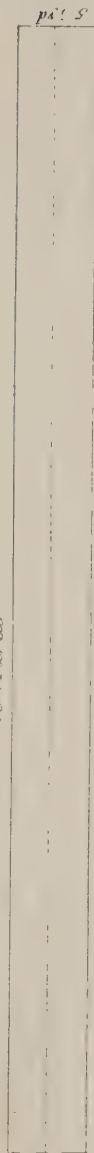


# 12 PR GUNS

## SOLID SHOT

6° by spirit level Axis 17 feet above the Plain  
 Obtained from 18 Rounds 15<sup>th</sup> April 1864.

78 Yards



MEAN RANGES  
 2384 Yards

B. L. ARMSTRONG

49 6 Yards



2665

WHITWORTH

57. 6. Yards



2564

M. L. ARMSTRONG

Scale of 12 Yards to one Inch.



# 12 PR GUNS

## SOLID SHOT

7° by spirit level Axis 17 feet above the Plain  
Obtained from 18 Rounds 15<sup>th</sup> April 1864.



Scale of 12 Yards to one Inch.

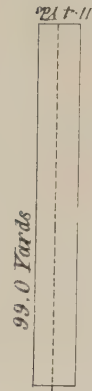




# SEGMENT AND SHRAPNELL SHELL

7° by spirit level, Axis 17 feet above the Plane  
 Obtained from 17 Rounds 23<sup>rd</sup> Feb<sup>ry</sup> 1865.

MEAN RANGES  
 2644 Yards



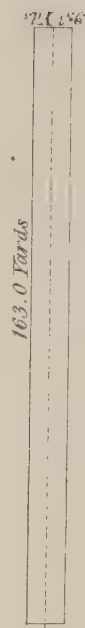
B. L. ARMSTRONG

2897



WHITWORTH

2798



M. L. ARMSTRONG

Scale of 48 Yards to one Inch.

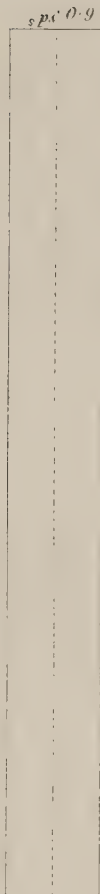


# 12 PR GUNS

## SOLID SHOT

8° by spirit level Axis 17 feet above the Plain.  
 Obtained from 18 Rounds 25<sup>th</sup> April 1864.

59 8. Yards



MEAN RANGES  
 2975 Yards

B. L. ARMSTRONG

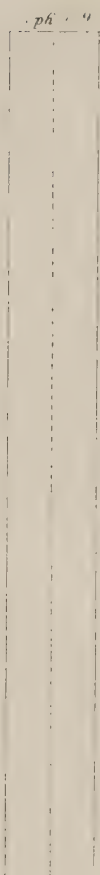
52 9 Yards



WHITWORTH

3325

58 3 Yards



M. L. ARMSTRONG

3099



# 12 PR GUNS

## SOLID SHOT

3° by spirit level Axis 17 feet above the Plain  
 Obtained from 18 Rounds.26<sup>th</sup> April 1864.

|                 |              |             |     |             |
|-----------------|--------------|-------------|-----|-------------|
| B. L. ARMSTRONG | 64. 5. Yards | <div></div> | 722 | MEAN RANGES |
|                 |              |             |     | 3224 Yards  |
| WHITWORTH       | 57. 4. Yards | <div></div> | 444 | 3655        |
|                 |              |             |     |             |
| M. L. ARMSTRONG | 75. 9. Yards | <div></div> | 444 | 3927        |
|                 |              |             |     |             |

Scale of 12 Yards to one Inch.



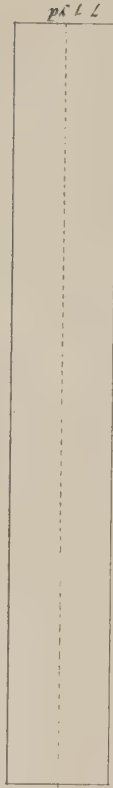
# 12 PR GUNS

## SOLID SHOT

10° by spirit level Axis 17 feet above the Plain  
 Obtained from 18 Rounds 27<sup>th</sup> April 1864.

B. L. ARMSTRONG

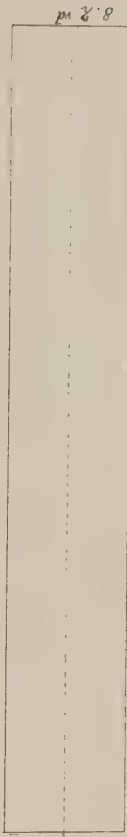
53 8 Yards



MEAN RANGES  
 3460 Yards

WHITWORTH

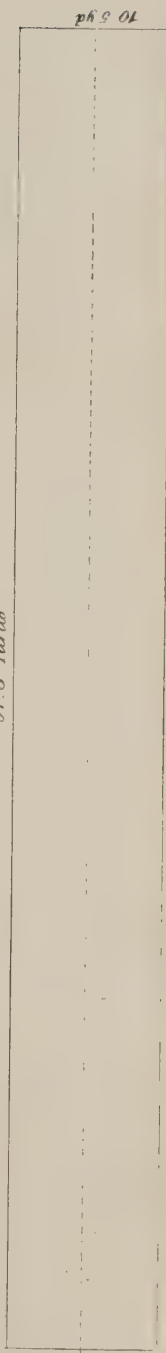
56.1 Yards



3918

M. L. ARMSTRONG

91.3 Yards



3524





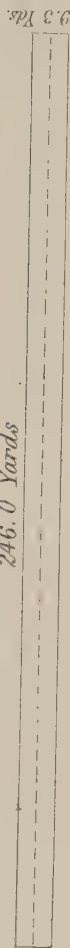
# 12 P<sub>R</sub> GUNS

## SEGMENT AND SHRAPNEL SHELL

10° by spirit level, Axis, 17 feet above the Plane  
 Obtained from 15 Rounds, 23<sup>rd</sup> Feb'y 1865.

B. L. ARMSTRONG

246.0 Yards



9.3 Yds.

MEAN RANGES  
 3306 Yards

WHITWORTH

230.6 Yards

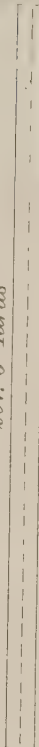


9.2 Yds.

3700

M. L. ARMSTRONG

201.6 Yards



7.9 Yds.

3600



# 12 PR GUNS

## SOLID SHOT

15° by spirit level Axis 17 feet above the Plain

Obtained from 9 Rounds 16<sup>th</sup> June 1864.

B. L. ARMSTRONG

94.9 Yards

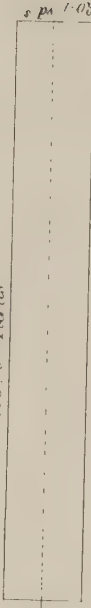
MEAN RANGES  
1710 Yards



WHITWORTH

159.6 Yards

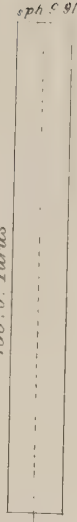
5665



M. L. ARMSTRONG

133.9 Yards

4719



Scale of 48 Yards to one Inch.

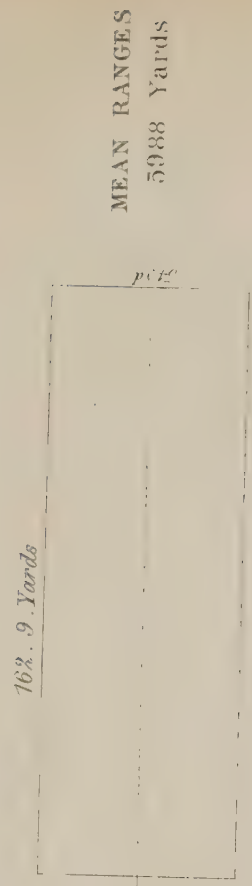


# 12 PR GUNS

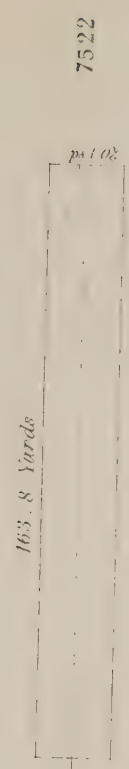
## SOLID SHOT

25° by spirit level Axis 17 feet above the Plain  
 Obtained from 9 Rounds 27<sup>th</sup> June 1864.

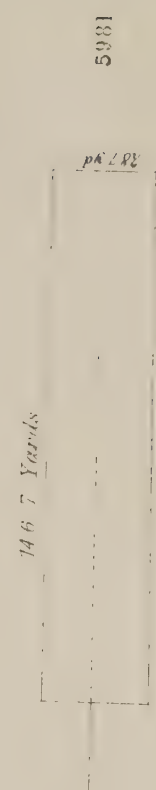
B. L. ARMSTRONG



WHITWORTH



M. L. ARMSTRONG



Scale of 18 Yards to one Inch



# 12 P<sup>R</sup> GUNS

## SOLID SHOT

33° by spirit level Axis 17 feet above the Plain  
 Obtained from 9 Rounds 23<sup>rd</sup> June 1864.

MEAN RANGES  
 6788 Yards

225.1 Yards

225.1

B. L. ARMSTRONG

222.9 Yards

222.9

WHITWORTH

201.7 Yards

201.7

M. L. ARMSTRONG

Scale of 48 Yards to one Inch.





## ROUGH USAGE.

*Practice on October 18, 1864.*

The 12-pounders that had been in the muddy ditch all night were this morning taken out, and with the view of ascertaining which of the guns could be got ready for action in the shortest possible time, the following experiment was carried out :—

The three guns being in the condition that they were in when taken out of the ditch, viz., covered more or less with thick mud, and with their bores more or less full of the same, were placed on the sea wall, detachments told off for them, and ten rounds

solid shot were fired from each as rapidly as possible, the time being taken from the word "load."

## RESULTS :—

Fired the 1st round in 3m. 30s.

" 10th " 7m. 50s.

*Note.*—Very considerable delay (amounting to probably one minute) was experienced in firing the first of these rounds, owing to the priming wire and prickler, &c. having been mislaid.

## EFFECT OF PREMATURE BURSTING OF SHELL IN THE BORE.

4 Common shell,

5 Segment shell,

were burst as nearly as possible at the seat of the shot.

To ensure this a hole was bored in the base of the shell and the lubricator and end of the cartridge removed so as to bring the cartridge in contact with the burster of the shell.

The bore was not damaged in the slightest degree.

10 rounds solid shot were fired at a target, the result showed that the accuracy of the gun was not impaired.

The ammunition did not appear to be in any way damaged.

*December 22, 1864.*

The gun was laid on skidding on the sand, and fired at with solid shot from a 9-pounder Armstrong gun. Charge,  $1\frac{1}{4}$  lb. Range, 40 yards.

*1st Shot.*—Struck the gun on the chase, made a slight dent, and glanced off, striking the shoulder of the trunnion, which it dented.

The direction of the shot was at an angle of  $30^\circ$  with the axis of the gun.

*2nd Shot.*—Struck full on the chase, knocked the gun two feet off the skidding, and dented it.

The gun was subsequently fired 4 rounds. At the second round the projectile stuck about 4 inches down the bore, but it was rammed home with little difficulty.

*October 28, 1864.*

10 rounds solid shot,

10 " shrapnel shell,

10 " common shell,

which were placed in wet straw in April last and periodically wetted with sea water, were fired to-day.

## RAPID FIRING.

*April 19, 1864.*

200 rounds of solid shot were fired, not as a competition as to rapidity of firing, but the firing to be continuous, carried on as rapidly as service considerations would admit of.

The gun detachment consisted of six men, and was relieved every 30 rounds.

The position of the gun was determined by lot, as follows :

Muzzle-loading Armstrong, No. 2, centre.

The gun detachments and officers were selected also by lot.

The time taken in firing the 200 rounds was as follows :—

1 hour 21 minutes.\*

At the conclusion of this firing the gun fired 8 rounds of common shell (blind) at 9-foot targets, 300 yards range, to hit the bull's eye ; three first rounds, trial shots ; 5 last recorded—

1. 7'00 inches from centre.
2. 4'25                   "
3. 7'5                   "
4. 5'25                   "
5. 14'25                  "

*May 19, 1864.*

99 rounds solid shot were fired entirely by men of the Royal Artillery, the gun detachment being changed every 30 rounds until 60 rounds had been fired, and

\* The cartridges were too high gauge for this gun ; several had to be rejected, as they would not enter the bore. The wads were not attached to the cartridges.

afterwards every 13 until the conclusion of the experiment.

One 6-foot floating target. Range, 1,200 yards. Elevation, 2° 17'.

|               |     | Min. | Sec. |
|---------------|-----|------|------|
| 1st 20 rounds | - - | 11   | 57   |
| 2nd 20   "    | - - | 10   | 7    |
| 3rd 20   "    | - - | 10   | 20   |
| 1st 13   "    | - - | 10   | 16   |
| 2nd 13   "    | - - | 8    | 16   |
| 3rd 13   "    | - - | 6    | 43   |
| Total         | - - | 57   | 39   |

21 hits on the target.

One high cartridge caused some little delay in 2nd 20 rounds.

*June 1, 1864.*

100 rounds of solid shot were fired by men of the Royal Artillery.

The detachments were changed every 20 rounds.

The gun was laid on a target at various distances.

First 2 shot trial.

The times taken were as follows :—

|           |     | Min. | Sec. |
|-----------|-----|------|------|
| 18 rounds | - - | 8    | 28   |
| 20   "    | - - | 7    | 45   |
| 20   "    | - - | 7    | 59   |
| 20   "    | - - | 7    | 32   |
| 20   "    | - - | 5    | 30   |
| Total     | - - | 37   | 14   |

Various trifling delays occurred during the 18 rounds, owing to the platform shifting.

## WITHOUT LUBRICATORS.

*November 10.*

20 rounds solid shot were fired without lubricators.

Time 9 minutes.

The practice was excellent.

66 rounds were then fired as rapidly as possible.

Time 19 minutes.

The detachments were changed so that each detachment worked each gun, and at the conclusion of

the practice Nos. 1, 2, 3, were asked their opinion as to ease of working.

No. 1 preferred Whitworth as easier to lay.

2   "   M.L. Armstrong as easier to load.

3   "   Whitworth, but could give no reason.

All agreed that the muzzle-loaders were far preferable to the breech-loader.

## SEA SERVICE TRIALS.

The gun was mounted on a common boat's carriage, in the bows of a 32-foot pinnace.

## INDEPENDENT FIRING.—November 3, 1864.

Ten rounds were fired from each gun independently with shot, the boats having very slight but rapid rolling, pitching, and yawing motions.

Wind  ; force, 2.

12-pounder Armstrong's  
Muzzle-loader—Shunt.

Shot, 12 lbs.  
Charge,  $1\frac{3}{4}$  lbs.  
Distance of target, 1,800 yards.  
Elevation,  $4^{\circ} 0'$ .

10 rounds were completed in  
15' 0".

Recoil, 2 ft. 6 in. and a taut  
breaching.

Sponging and loading was  
performed with difficulty,  
owing to the length of the  
gun. The loading num-  
bers were much exposed,  
and the sponge being high,  
delayed the gun.

Total numbers gained in this  
practice - - - 53

November 8, 1864.

## DISEMBARKING.

The 12-pounder competitive guns were thrown ashore (on Southsea beach) from the boats, and practised without loss of time as naval field pieces, to ascertain their comparative merits under the circumstances.

Guns, field carriages, and limbers were thrown overboard, as the boats touched the beach, and roused ashore by the drag ropes. The limber boxes were carried on shore by the limber numbers. When the guns were mounted they were "Rear" limbered up and marched about 10 yards higher up the beach; then "Action—Rear," "Load," "1° elevation and lay for the horizon," "Fire," "Cease—Firing."

The following several period of time are recorded against each gun during the evolutions; the difference between the times connected with the mounting of carriage and limber must be attributed to the crews only; but those connected with the handling of the guns may fairly be due to their difference in weight and handiness.

| Boats touching beach to the time when |   |   | m.         | s. |
|---------------------------------------|---|---|------------|----|
| guns were overboard                   | - | - | 0          | 30 |
| Carriage landed                       | - | - | 1          | 20 |
| " mounted                             | - | - | 2          | 0  |
| Limber landed                         | - | - | Not taken. |    |
| " mounted                             | - | - | 3          | 22 |
| Gun mounted                           | - | - | *4         | 30 |
| "Rear—Limber up"                      | - | - | 4          | 36 |
| "Action—Rear"                         | - | - | 6          | 40 |
| "Load" †                              | - | - | 6          | 44 |
| "Fire"                                | - | - | 8          | 15 |

Very little cleansing was required;  
the guns were dragged breech foremost  
through water, sand, and shingle.

## ABSTRACT OF PRACTICE.

|                                                                                       |              |      |               |       |                          |       |                               |  |                                                       |  |
|---------------------------------------------------------------------------------------|--------------|------|---------------|-------|--------------------------|-------|-------------------------------|--|-------------------------------------------------------|--|
| 12-pounder guns in boats.<br>November 3, 1864.<br>Independent firing,<br>1,800 yards. | Rounds.      |      | Time.         |       | Average Time each Round. |       | Numbers awarded for Accuracy. |  | Remarks.                                              |  |
|                                                                                       | 10           |      | m. s.<br>15 0 |       | m. s.<br>1 30            |       | 53                            |  | Recoil manageable. Sponge being high delayed the gun. |  |
|                                                                                       | Mounting.    |      |               |       | Orders.                  |       |                               |  | Remarks.                                              |  |
| Carriage.                                                                             |              | Gun. |               | Load. |                          | Fire. |                               |  |                                                       |  |
| 12-pounder guns landed on Southsea beach as field pieces.                             | m. s.<br>2 0 |      | m. s.<br>4 30 |       | m. s.<br>6 44            |       | m. s.<br>8 15                 |  | The sponging was but the ordinary proceeding.         |  |

\* The handspike across the rear of the gun slipped repeatedly.

† The order "Load" followed immediately, "Action—Rear."

## INITIAL VELOCITY AND RETARDATION.

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The following abstracts show the results of experiments made to ascertain the initial velocity and retardation of projectiles fired from the Armstrong and Whitworth 12-pounder guns.

The experiments were carried on at Shoeburyness on the 2nd, 3rd, and 4th May and 12th August 1864. The velocities being determined by means of the electro-ballistic pendulum, invented by Major Navez, of the Belgian Artillery, two of these instruments were employed simultaneously in the investigations, and the velocity of each shot was determined at two points in the trajectory, one near the muzzle of the gun, the other at a considerable distance from it; the velocity which the projectile lost in passing over the space included between the two points was thus ascertained:—Five good observations were obtained with each projectile.

The common shell were all brought to the same weight, so that the guns might be tested under similar circumstances as regards weight of charge and weight of projectile.

The velocities of the projectiles were observed at 40, 440, and 840 yards from the muzzle.

*Table I.* shows the mean observed velocity of the projectiles.

*Table II.* shows the comparative gain and loss of velocity of the projectiles.

*Table III.* shows the details of the practice with Whitworth gun.

*Table IV.* shows the details of the practice with the M.L. Armstrong gun.

*Table V.* shows the details of the practice with the B.L. Armstrong gun.

*Table VI.* shows the density of the air on each day during the experiments.



TABLE I.

TABLE showing the mean observed Velocities, &c. of Projectiles fired from Armstrong and Whitworth competitive Field Guns.

| No. of Rounds. | Nature of Gun.          | Charge.                 | Projectile.                           |         | Proportion between Weight of Projectile and Weight of Charge. | Mean observed Velocities. |               |                    | Calculated mean initial Velocity. |
|----------------|-------------------------|-------------------------|---------------------------------------|---------|---------------------------------------------------------------|---------------------------|---------------|--------------------|-----------------------------------|
|                |                         |                         | Nature.                               | Weight. |                                                               | At 40 Yards.              | At 840 Yards. | Lost in 800 Yards. |                                   |
|                |                         | Lbs.<br>A4.<br>Lot 510. |                                       | Lbs.    |                                                               | Feet.                     | Feet.         | Feet.              | Feet.                             |
| 5              | 12-pr. M.L. Whitworth - | 1.75                    | Common shell                          | 11.75   | 0.1489                                                        | 1265.5                    | 1100.2        | 165.3              | 1277.9                            |
| 5              | 12-pr. M.L. Armstrong - | 1.75                    | "                                     | "       | "                                                             | 1343.4                    | 1104.5        | 238.9              | 1358.5                            |
| 5              | 12-pr. B.L. Armstrong - | 1.75                    | "                                     | "       | 0.1489                                                        | 1309.1                    | not obs.      | not obs.           | 1319.5                            |
| 5              | 12-pr. B.L. Armstrong - | 1.50                    | "                                     | "       | 0.1277                                                        | 1225.5                    | 1040.8        | 184.7              | 1238.8                            |
| 5              | 12-pr. M.L. Whitworth - | 1.75                    | } Shrapnel or<br>segment<br>shell - { | 12.06   | 0.1451                                                        | 1245.9                    | 1091.0        | 155.0              | 1257.9                            |
| 5              | 12-pr. M.L. Armstrong - | 1.75                    |                                       | 11.53   | 0.1518                                                        | 1337.3                    | 1093.8        | 243.5              | 1352.4                            |
| 5              | 12-pr. B.L. Armstrong - | 1.50                    |                                       | 11.66   | 0.1286                                                        | 1235.3                    | 1045.5        | 189.8              | 1248.6                            |
| 5              | 12-pr. M.L. Whitworth - | 1.75                    | Solid shot -                          | 11.87   | 0.1474                                                        | 1270.9                    | 1094.3        | 176.6              | 1283.3                            |
| 5              | 12-pr. M.L. Armstrong - | 1.75                    | " -                                   | 11.56   | 0.1514                                                        | 1341.0                    | 1093.5        | 247.5              | 1356.2                            |
| 5              | 12-pr. B.L. Armstrong - | 1.50                    | " -                                   | "       | 0.1298                                                        | 1233.3                    | 1042.6        | 190.7              | 1246.6                            |
|                |                         |                         |                                       |         |                                                               | At 440 Yards.             |               | In 400 Yards.      |                                   |
| 5              | 12-pr. M.L. Whitworth - | 1.75                    | Solid shot -                          | 11.87   | 0.1474                                                        | 1276.2                    | 1163.5        | 112.7              | 1288.6                            |
| 5              | 12-pr. M.L. Armstrong - | 1.75                    | " -                                   | 11.56   | 0.1514                                                        | 1342.4                    | 1185.4        | 157.0              | 1357.5                            |
| 5              | 12-pr. B.L. Armstrong - | 1.50                    | " -                                   | "       | 0.1298                                                        | 1228.6                    | 1107.9        | 120.7              | 1241.9                            |
| I.             | II.                     | III.                    | IV.                                   | V.      | VI.                                                           | VII.                      | VIII.         | IX.                | X.                                |

DESCRIPTION OF TABLE I.

Column I. Number of rounds included in the mean total.  
 " II. Nature of ordnance used.  
 " III. Weight of charge in pounds, and brand of powder.  
 " IV. & V. Nature and weight of projectile.  
 " VI. Proportion between the weight of projectile and weight of charge, or weight of charge in pounds divided by weight of projectile in pounds.  
 " VII. The velocity of the projectile, in feet per second, at a distance of 40 yards from the muzzle of the gun.

Column VIII. The velocity of the projectile, in feet per second, at a distance of 840 yards from the muzzle of the gun. Lower in the column at 440 yards.  
 " IX. The velocity, in feet, lost in passing through 800 yards of air. Lower in the column, the loss in 400 yards, or the difference between columns VII. and VIII.  
 " X. The calculated velocity at the muzzle of the gun.

TABLE II.

TABLE showing the comparative Gain and Loss in Velocity of Projectiles fired from Armstrong and Whitworth competitive Field Guns, the 12-pounder Whitworth being taken as the standard.

| Nature of Gun.          | Charge. | Nature of Projectile.                 | Initial Velocity. |           |           | Observed loss of Velocity in 800 Yards. |           |               |
|-------------------------|---------|---------------------------------------|-------------------|-----------|-----------|-----------------------------------------|-----------|---------------|
|                         |         |                                       | Rate per Second.  | Increase. | Decrease. | Amount.                                 | Increase. | Decrease.     |
|                         | Lbs.    |                                       | Feet.             |           |           | Feet.                                   |           |               |
| 12-pr. M.L. Whitworth - | 1.75    | Common shell                          | 1277.9            | -         | -         | 165.3                                   | -         | -             |
| 12-pr. M.L. Armstrong - | 1.75    | "                                     | 1358.5            | 80.6      | -         | 238.9                                   | 73.6      | -             |
| 12-pr. B.L. Armstrong - | 1.75    | "                                     | 1319.5            | 41.6      | -         | not obs.                                | -         | -             |
| 12-pr. B.L. Armstrong - | 1.50    | "                                     | 1238.8            | -         | 39.1      | 184.7                                   | 19.4      | -             |
| 12-pr. M.L. Whitworth - | 1.75    | } Shrapnel or<br>segment<br>shell - { | 1257.9            | -         | -         | 155.0                                   | -         | -             |
| 12-pr. M.L. Armstrong - | 1.75    |                                       | 1352.4            | 94.5      | -         | 243.5                                   | 88.5      | -             |
| 12-pr. B.L. Armstrong - | 1.50    |                                       | 1248.6            | -         | 9.3       | 189.8                                   | 34.8      | -             |
| 12-pr. M.L. Whitworth - | 1.75    | Solid shot -                          | 1283.3            | -         | -         | 176.6                                   | -         | -             |
| 12-pr. M.L. Armstrong - | 1.75    | " -                                   | 1356.2            | 72.9      | -         | 247.5                                   | 70.9      | -             |
| 12-pr. B.L. Armstrong - | 1.50    | " -                                   | 1246.6            | -         | 36.7      | 190.7                                   | 14.1      | -             |
|                         |         |                                       |                   |           |           | In 400 Yards.                           |           | In 400 Yards. |
| 12-pr. M.L. Whitworth - | 1.75    | Solid shot -                          | 1288.6            | -         | -         | 112.7                                   | -         | -             |
| 12-pr. M.L. Armstrong - | 1.75    | " -                                   | 1357.5            | 68.9      | -         | 157.0                                   | 34.3      | -             |
| 12-pr. B.L. Armstrong - | 1.50    | " -                                   | 1241.9            | -         | 46.7      | 120.7                                   | 8.0       | -             |
| I.                      | II.     | III.                                  | IV.               | V.        | VI.       | VII.                                    | VIII.     | IX.           |

DESCRIPTION OF TABLE II.

Column I. Nature of ordnance used.  
 " II. Weight of the charge in pounds.  
 " III. Nature of projectile used.  
 " IV. Velocity, in feet per second, of projectile at the muzzle of the gun.  
 " V. & VI. Difference between the velocities of the Armstrong projectiles and the Whitworth projectile.

Column VII. The amount of velocity, in feet, which the projectile lost in 800 yards. Vide Table I., col. IX.  
 " VIII. & IX. Difference between the loss experienced by the Armstrong projectiles and the Whitworth projectile.

TABLE III.

TABLE showing the Total Number of Rounds fired for Velocity and Retardation. Armstrong and Whitworth competitive Field Guns.

12-Pounder M.L. Whitworth Gun, R. No. 264.

| Date of Experiment. | No. of Round. | Charge.   | Projectile.                                                            |              |                            | Observed Velocities. |                      |                    | Remarks.                              |
|---------------------|---------------|-----------|------------------------------------------------------------------------|--------------|----------------------------|----------------------|----------------------|--------------------|---------------------------------------|
|                     |               |           | Nature.                                                                | Mean Weight. | Mean Diameter.             | At 40 Yards.         | At 840 Yards.        | Lost in 800 Yards. |                                       |
| 2/5/64              | 1             | Lbs. 1.75 | Common shell with wood time fuze (Boxer) fixed, length, 10.889 inches. | Lbs. 11.75   | Inches. { 2.975<br>2.714 } | Feet. 1256.7         | Feet. 1095.2         | Feet. 161.5        | 16 rounds fired to obtain these hits. |
| "                   | 2             | "         |                                                                        | "            | "                          | 1270.7               | 1105.5               | 165.2              |                                       |
| "                   | 3             | "         |                                                                        | "            | "                          | 1255.6               | 1094.3               | 161.3              |                                       |
| "                   | 4             | "         |                                                                        | "            | "                          | 1277.2               | 1115.2               | 162.0              |                                       |
| "                   | 5             | "         |                                                                        | "            | "                          | 1267.4               | 1090.9               | 176.5              |                                       |
| 4/5/64              | 1             | "         | Shrapnel shell with wood time fuze (Boxer) fixed.                      | 12.06        | "                          | 1247.0               | 1092.0               | 155.0              | 7 rounds fired to obtain these hits.  |
| "                   | 2             | "         |                                                                        | "            | "                          | 1244.9               | 1088.5               | 156.4              |                                       |
| "                   | 3             | "         |                                                                        | "            | "                          | 1241.7               | 1089.5               | 152.2              |                                       |
| "                   | 4             | "         |                                                                        | "            | "                          | 1244.9               | 1093.7               | 151.2              |                                       |
| "                   | 5             | "         |                                                                        | "            | "                          | 1251.2               | 1091.1               | 160.1              |                                       |
| 3/5/64              | 1             | "         | Solid shot, length 8.69 inches.                                        | 11.875       | "                          | 1265.3               | 1092.0               | 173.3              | 6 rounds fired to obtain these hits.  |
| "                   | 2             | "         |                                                                        | "            | "                          | 1295.1               | 1106.8               | 188.3              |                                       |
| "                   | 3             | "         |                                                                        | "            | "                          | 1272.9               | 1096.3               | 176.6              |                                       |
| "                   | 4             | "         |                                                                        | "            | "                          | 1244.0               | 1080.8               | 163.2              |                                       |
| "                   | 5             | "         |                                                                        | "            | "                          | 1277.2               | 1095.4               | 181.8              |                                       |
| 3/5/64              | 1             | "         | Solid shot, length 8.69 inches.                                        | "            | "                          | At 440 Yards. 1278.4 | In 400 Yards. 1173.1 | 105.3              | 6 rounds fired to obtain these hits.  |
| "                   | 2             | "         |                                                                        | "            | "                          | 1290.6               | 1178.8               | 111.8              |                                       |
| "                   | 3             | "         |                                                                        | "            | "                          | 1269.7               | 1155.9               | 113.8              |                                       |
| "                   | 4             | "         |                                                                        | "            | "                          | 1275.1               | 1155.0               | 120.1              |                                       |
| "                   | 5             | "         |                                                                        | "            | "                          | 1267.5               | 1155.0               | 112.5              |                                       |
| I.                  | II.           | III.      | IV.                                                                    | V.           | VI.                        | VII.                 | VIII.                | IX.                | X.                                    |

Lubricating wads used throughout.

TABLE IV.

TABLE showing the Total Number of Rounds fired for Velocity and Retardation. Armstrong and Whitworth competitive Field Guns.

12-pounder M.L. Armstrong "Shunt" Gun R., No. 52.

| Date of Experiment. | No. of Rounds. | Charge.   | Projectile.                                                           |            |              | Observed Velocities. |                      |                    | Remarks.                             |
|---------------------|----------------|-----------|-----------------------------------------------------------------------|------------|--------------|----------------------|----------------------|--------------------|--------------------------------------|
|                     |                |           | Nature.                                                               | Weight.    | Diameter.    | At 40 Yards.         | At 840 Yards.        | Lost in 800 Yards. |                                      |
| 2/5/64              | 1              | Lbs. 1.75 | Common shell with brass screw concussion fuze fixed, length, 9.01 in. | Lbs. 11.75 | Inches. 2.94 | Feet. 1370.7         | Feet. 1117.7         | Feet. 253.0        | 8 rounds fired to obtain these hits. |
| "                   | 2              | "         |                                                                       | "          | "            | 1341.4               | 1099.0               | 242.4              |                                      |
| "                   | 3              | "         |                                                                       | "          | "            | 1330.7               | 1106.0               | 224.7              |                                      |
| "                   | 4              | "         |                                                                       | "          | "            | 1335.4               | 1098.1               | 237.3              |                                      |
| "                   | 5              | "         |                                                                       | "          | "            | 1339.0               | 1101.6               | 237.4              |                                      |
| 4/5/64              | 1              | "         | Segment shell, with brass time fuze fixed.                            | 11.53      | "            | 1340.8               | 1099.0               | 241.8              | 8 rounds fired to obtain these hits. |
| "                   | 2              | "         |                                                                       | "          | "            | 1345.6               | 1097.3               | 248.3              |                                      |
| "                   | 3              | "         |                                                                       | "          | "            | 1340.8               | 1096.4               | 244.4              |                                      |
| "                   | 4              | "         |                                                                       | "          | "            | 1313.6               | 1076.5               | 237.1              |                                      |
| "                   | 5              | "         |                                                                       | "          | "            | 1345.6               | 1099.7               | 245.9              |                                      |
| 3/5/64              | 1              | "         | Solid shot, length 7.56 in.                                           | 11.562     | "            | 1346.4               | 1104.2               | 242.2              | 5 rounds fired to obtain these hits. |
| "                   | 2              | "         |                                                                       | "          | "            | 1316.7               | 1080.9               | 235.8              |                                      |
| "                   | 3              | "         |                                                                       | "          | "            | 1340.4               | 1087.8               | 252.6              |                                      |
| "                   | 4              | "         |                                                                       | "          | "            | 1340.4               | 1088.6               | 251.8              |                                      |
| "                   | 5              | "         |                                                                       | "          | "            | 1361.0               | 1106.0               | 255.0              |                                      |
| "                   | 1              | "         | Solid shot, length 7.56 in.                                           | "          | "            | At 440 Yards. 1318.6 | In 400 Yards. 1166.8 | 151.8              | 5 rounds fired to obtain these hits. |
| "                   | 2              | "         |                                                                       | "          | "            | 1342.3               | 1187.1               | 155.2              |                                      |
| "                   | 3              | "         |                                                                       | "          | "            | 1358.0               | 1194.1               | 163.9              |                                      |
| "                   | 4              | "         |                                                                       | "          | "            | 1360.5               | 1200.1               | 160.4              |                                      |
| "                   | 5              | "         |                                                                       | "          | "            | 1332.7               | 1179.1               | 153.6              |                                      |
| I.                  | II.            | III.      | IV.                                                                   | V.         | VI.          | VII.                 | VIII.                | IX.                | X.                                   |

No lubricators used; small junk wad placed over the cartridge.

TABLE V.

TABLE showing the Total Number of Rounds fired for Velocity and Retardation. Armstrong and Whitworth competitive Field Guns.

12-pounder B.L. Armstrong Gun R. Expl. No. 38, E.O.C.

| Date of Experiment. | No. of Round. | Charge.   | Projectile.                                                          |             |                   | Observed Velocities.        |               |                    | Remarks.                             |
|---------------------|---------------|-----------|----------------------------------------------------------------------|-------------|-------------------|-----------------------------|---------------|--------------------|--------------------------------------|
|                     |               |           | Nature.                                                              | Weight.     | Diameter at back. | At 40 Yards.                | At 840 Yards. | Lost in 800 Yards. |                                      |
| 2/5/64              | 1             | Lbs. 1.50 | Commonshell, with brass screw concussion fuze fixed, length 9.01 in. | Lbs. 11.750 | Inches. 3.08      | Feet. 1219.1                | Feet. 1040.4  | Feet. 178.7        | 8 rounds fired to obtain these hits. |
| "                   | 2             | "         |                                                                      | "           | "                 | 1241.8                      | 1051.0        | 190.8              |                                      |
| "                   | 3             | "         |                                                                      | "           | "                 | 1210.0                      | 1034.1        | 175.9              |                                      |
| "                   | 4             | "         |                                                                      | "           | "                 | 1228.3                      | 1041.2        | 187.1              |                                      |
| "                   | 5             | "         |                                                                      | "           | "                 | 1228.3                      | 1037.2        | 191.1              |                                      |
| 12/8/64             | 1             | 1.75      | "                                                                    | "           | "                 | 1311.4                      | not obs.      | not obs.           |                                      |
| "                   | 2             | "         | "                                                                    | "           | "                 | 1297.7                      |               |                    |                                      |
| "                   | 3             | "         | "                                                                    | "           | "                 | 1310.2                      |               |                    |                                      |
| "                   | 4             | "         | "                                                                    | "           | "                 | 1320.7                      |               |                    |                                      |
| "                   | 5             | "         | "                                                                    | "           | "                 | 1305.6                      |               |                    |                                      |
| 4/5/64              | 1             | 1.50      | Segment shell, with brass time fuze fixed.                           | Lbs. 11.656 | "                 | 1243.4                      | 1051.7        | 191.7              | 9 rounds fired to obtain these hits. |
| "                   | 2             | "         |                                                                      | "           | "                 | 1227.6                      | 1042.0        | 185.6              |                                      |
| "                   | 3             | "         |                                                                      | "           | "                 | 1230.7                      | 1042.0        | 188.7              |                                      |
| "                   | 4             | "         |                                                                      | "           | "                 | 1237.0                      | 1046.8        | 190.2              |                                      |
| "                   | 5             | "         |                                                                      | "           | "                 | 1238.0                      | 1045.2        | 192.8              |                                      |
| 3/5/64              | 1             | "         | Solid shot, length 6.99 in.                                          | Lbs. 11.562 | "                 | 1215.1                      | 1035.0        | 180.1              | 9 rounds fired to obtain these hits. |
| "                   | 2             | "         |                                                                      | "           | "                 | 1230.2                      | 1042.1        | 188.1              |                                      |
| "                   | 3             | "         |                                                                      | "           | "                 | 1242.9                      | 1048.6        | 194.3              |                                      |
| "                   | 4             | "         |                                                                      | "           | "                 | 1238.7                      | 1043.8        | 194.9              |                                      |
| "                   | 5             | "         |                                                                      | "           | "                 | 1239.8                      | 1043.8        | 196.0              |                                      |
|                     |               |           |                                                                      |             |                   | At 440 Yards. In 400 Yards. |               |                    |                                      |
| "                   | 1             | "         | Solid shot, length 6.99 in.                                          | "           | "                 | 1239.4                      | 1119.2        | 120.2              | 8 rounds fired to obtain these hits. |
| "                   | 2             | "         |                                                                      | "           | "                 | 1221.9                      | 1099.0        | 122.9              |                                      |
| "                   | 3             | "         |                                                                      | "           | "                 | 1230.1                      | 1097.2        | 132.9              |                                      |
| "                   | 4             | "         |                                                                      | "           | "                 | 1228.0                      | 1112.1        | 115.9              |                                      |
| "                   | 5             | "         |                                                                      | "           | "                 | 1223.9                      | 1112.1        | 111.8              |                                      |
| I.                  | II.           | III.      | IV.                                                                  | V.          | VI.               | VII.                        | VIII.         | IX.                | X.                                   |

Lubricating wads used throughout.

#### DESCRIPTION OF TABLES III., IV., and V.

|                  |                                                                     |                   |                                                                                                                            |
|------------------|---------------------------------------------------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------|
| Column I.        | Date on which the experiment detailed in the Table was carried out. | Col. VII. & VIII. | The velocities of the projectiles at each round. Columns VII and VIII, Table I, give the means of these velocities.        |
| " II.            | Number of the round, in the order in which it was fired.            | " IX.             | The loss in 800 yards, or the difference between Columns VII and VIII. Column IX, Table I, gives the mean of these losses. |
| " III.           | Weight of charge, in pounds.                                        | " X.              | Remarks. Number of rounds which were necessary to fire, in order to hit the wire screens at 800 yards &c.                  |
| " IV., V., & VI. | Nature, weight in pounds, and diameter in inches of the projectile. |                   |                                                                                                                            |

TABLE VI.

TABLE showing the Density of the Air on each Day of Experiment with Navez's apparatus, during the trial of the 12-pounder competitive Armstrong and Whitworth guns. The weight of one Cubic Foot of Dry Air at a temperature of 32° Fahrenheit, and pressure of 30 inches = 563 grains being taken as the unit.

| Date.   | Barometer observed at 3 p.m. |              | Barometer corrected. | Thermometer observed. |      | Relative Humidity. | Weight of One Cubic Foot of Air. | Relative Proportion to Standard. | Remarks.]            |
|---------|------------------------------|--------------|----------------------|-----------------------|------|--------------------|----------------------------------|----------------------------------|----------------------|
|         | Height.                      | Temperature. |                      | Dry.                  | Wet. |                    |                                  |                                  |                      |
| 2/5/64  | Inches. 29.80                | ° 59         | Inches. 29.71        | ° 63                  | ° 59 | 0.798              | Grains. 520.8                    | 0.9747                           | Wind. N.W., 5; hazy. |
| 3/5/64  | 29.90                        | 55           | 29.83                | 52                    | 51   | 0.934              | 535.0                            | 1.0013                           | N.E., 2; clear.      |
| 4/5/64  | 29.88                        | 52           | 28.82                | 49                    | 48   | 0.930              | 537.7                            | 1.0064                           | S.E., 3; rain.       |
| 12/8/64 | 30.30                        | 64           | 30.20                | 65                    | 58   | 0.687              | 527.8                            | 0.9878                           | S.E., 2; fine.       |
| I.      | II.                          | III.         | IV.                  | V.                    | VI.  | VII.               | VIII.                            | IX.                              | X.                   |

Standard weight of one cubic foot of air at 60° Fahrenheit, with pressure of 30 inches, and saturation 0.5, being equal to 534.3 grains.

#### DESCRIPTION OF TABLE VI.

|            |                                                                |              |                                                                              |
|------------|----------------------------------------------------------------|--------------|------------------------------------------------------------------------------|
| Column I.  | Date on which the observations were made.                      | Column VIII. | Actual weight of one cubic foot of air on that date.                         |
| " II.      | Observed height of the barometer.                              | " IX.        | Proportion to standard; assuming that the standard 534.3 grains equals 1.00. |
| " III.     | Temperature of barometer.                                      | " X.         | Remarks. Direction and force of wind, &c.                                    |
| " IV.      | Barometer corrected for temperature.                           |              |                                                                              |
| " V. & VI. | Readings of wet and dry bulb thermometer.                      |              |                                                                              |
| " VII.     | Relative amount of moisture in the air, saturation being 1.00. |              |                                                                              |



TABLE showing the ANGLES of DESCENT of SOLID SHOT, fired from 12-Pr. Field Guns with SERVICE CHARGES at 1,000 YARDS.

| Nature of Gun.                  | No. of Rounds. | Charge.   | Mean Weight of Shot. | Elevation by Tangent. | Observed Height of Point struck on vertical Screw at 1,000 Yards. | Left Deflection allowed. | Deflection observed. |         | Range.       | Difference from 1,000 Yards. | Angle of Descent. | Excess over Angle of Elevation. | Remarks.                                                                                                                                                                                                                                                           |
|---------------------------------|----------------|-----------|----------------------|-----------------------|-------------------------------------------------------------------|--------------------------|----------------------|---------|--------------|------------------------------|-------------------|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                 |                |           |                      |                       |                                                                   |                          | Left.                | Right.  |              |                              |                   |                                 |                                                                                                                                                                                                                                                                    |
| 12-pr. Muzzle-Loading Armstrong | 1              | lbs. 1.75 | lbs. 11.56           | ° 1 36                | Feet. 21.83                                                       | Minutes. 6               | Feet. 2.5            | Feet. — | Yards. 1,155 | Feet. 465                    | ° 2 41            | ° 1 5                           | This experiment was carried out by means of a vertical net, 40' x 30', stretched on poles at a distance of 1,000 yards. The guns were laid at a bull's-eye in the centre of the net, 17.5 feet above the plane. The axis of the gun was 17.5 feet above the plane. |
|                                 | 2              | "         | "                    | "                     | 14.25                                                             | "                        | Line.                |         | 1,099        | 297                          | 2 45              | 1 9                             |                                                                                                                                                                                                                                                                    |
|                                 | 3              | "         | "                    | "                     | 15.17                                                             | "                        | 0.33                 | —       | 1,106        | 318                          | 2 44              | 1 8                             |                                                                                                                                                                                                                                                                    |
|                                 | 4              | "         | "                    | "                     | 14.00                                                             | "                        | —                    | 1.00    | 1,097        | 291                          | 2 45              | 1 9                             |                                                                                                                                                                                                                                                                    |
|                                 | 5              | "         | "                    | "                     | 15.00                                                             | "                        | 0.75                 | —       | 1,104        | 312                          | 2 45              | 1 9                             |                                                                                                                                                                                                                                                                    |
|                                 | Mean           | "         | "                    | "                     | 16.05                                                             | "                        | —                    | —       | 1,112.2      | 336.6                        | 2 44              | 1 8                             |                                                                                                                                                                                                                                                                    |
| 12-pr. Breech-Loading Armstrong | 1              | 1.50      | "                    | 1 59                  | 6.75                                                              | "                        | —                    | 2.0     | 1,041        | 123                          | 3 9               | 1 10                            |                                                                                                                                                                                                                                                                    |
|                                 | 2              | "         | "                    | "                     | 12.00                                                             | "                        | 1.5                  | —       | 1,071        | 213                          | 3 13              | 1 14                            |                                                                                                                                                                                                                                                                    |
|                                 | 3              | "         | "                    | "                     | 15.50                                                             | "                        | —                    | 2.5     | 1,100        | 300                          | 2 57              | 0 58                            |                                                                                                                                                                                                                                                                    |
|                                 | 4              | "         | "                    | "                     | 16.17                                                             | "                        | 1.5                  | —       | 1,102        | 306                          | 3 1               | 1 2                             |                                                                                                                                                                                                                                                                    |
|                                 | 5              | "         | "                    | "                     | 12.25                                                             | "                        | 1.17                 | —       | 1,080        | 240                          | 2 55              | 0 56                            |                                                                                                                                                                                                                                                                    |
|                                 | Mean           | "         | "                    | "                     | 12.53                                                             | "                        | —                    | —       | 1,078.8      | 238.4                        | 3 3               | 1 4                             |                                                                                                                                                                                                                                                                    |
| 12-pr. Muzzle-Loading Whitworth | 1              | 1.75      | 11.87                | 1 36                  | 12.75                                                             | 2.5                      | —                    | 6.0     | 1,090        | 270                          | 2 42              | 1 6                             |                                                                                                                                                                                                                                                                    |
|                                 | 2              | "         | "                    | "                     | 9.25                                                              | "                        | —                    | 6.25    | 1,063        | 189                          | 2 48              | 1 12                            |                                                                                                                                                                                                                                                                    |
|                                 | 3              | "         | "                    | "                     | 11.17                                                             | "                        | —                    | 4.0     | 1,076        | 228                          | 2 48              | 1 12                            |                                                                                                                                                                                                                                                                    |
|                                 | 4              | "         | "                    | "                     | 10.75                                                             | "                        | —                    | 6.75    | 1,074        | 222                          | 2 47              | 1 11                            |                                                                                                                                                                                                                                                                    |
|                                 | 5              | "         | "                    | "                     | 14.42                                                             | "                        | —                    | 1.5     | 1,098        | 294                          | 2 48              | 1 12                            |                                                                                                                                                                                                                                                                    |
|                                 | Mean           | "         | "                    | "                     | 11.67                                                             | "                        | —                    | —       | 1,080.2      | 240.6                        | 2 46              | 1 11                            |                                                                                                                                                                                                                                                                    |

# **70-PR. GUNS.**

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**EXPERIMENTS carried out by the SPECIAL ARMSTRONG  
and WHITWORTH COMMITTEE.**



70-POUNDER WEDGE BREECH-LOADING ARMSTRONG GUN.

EXPERIMENTS FOR DETERMINING RANGE AND ACCURACY.

N.B.—The figures in *Italics* are the rounds struck out by the competitors as abnormal shots.

SHOT (HOLLOW-HEADED). SHOE BURYNESS.

*Particulars of Gun.*  
Weight, 61·6 cwt.  
Length, 9 ft. 1·95 in.  
Diameter of bore, 6·4 in.  
Length of bore, 7 ft. 7·95 in.  
Grooves { No. 70.  
          { Width, 0·175 in.  
          { Depth, 0·85 in.  
Spiral, 1 turn in 40 calibres.

*Particulars of Projectile and Ammunition.*  
Weight, 71·87 lbs.  
Diameter, 6·43 in.  
Length, 12·26 in.  
Length of cartridge, 12 in.  
Diameter of cartridge, 5 in.  
Brand of powder, A4.  
Charge, 9 lbs.  
Wad, service lubricator.

| No. of Round. | Elevation.   | Range. | 1st Graze. | Remarks.                                                                                                                                                       |          |              |       |            |       |           |
|---------------|--------------|--------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|------------|-------|-----------|
|               |              |        | Right.     |                                                                                                                                                                |          |              |       |            |       |           |
|               | °            | Yards. | Yards.     |                                                                                                                                                                |          |              |       |            |       |           |
|               |              |        |            | October 14, 1864.                                                                                                                                              |          |              |       |            |       |           |
| 1             | 0            | 459    | 19·2       |                                                                                                                                                                |          |              |       |            |       |           |
| 2             | "            | 405    | 20·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 3             | "            | 454    | 19·8       |                                                                                                                                                                |          |              |       |            |       |           |
| 4             | "            | 433    | 18·4       |                                                                                                                                                                |          |              |       |            |       |           |
| 5             | "            | 464    | 18·8       |                                                                                                                                                                |          |              |       |            |       |           |
| 6             | "            | 441    | 19·4       | The gun was 58 feet right of line.                                                                                                                             |          |              |       |            |       |           |
| 7             | "            | 444    | 20·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 8             | "            | 478    | 18·8       | Weather :—Very thick haze.                                                                                                                                     |          |              |       |            |       |           |
| 9             | "            | 439    | 19·4       |                                                                                                                                                                |          |              |       |            |       |           |
| 10            | "            | 462    | 20·0       | Wind :—Direction, N.W. ; force, 2 ; 10 a.m.                                                                                                                    |          |              |       |            |       |           |
| 11            | "            | 448    | 19·6       | " " " 2 ; 3 p.m.                                                                                                                                               |          |              |       |            |       |           |
| 12            | "            | 437    | 19·6       |                                                                                                                                                                |          |              |       |            |       |           |
| 13            | "            | 444    | 20·2       | Thermometer :—53 dry, 52 wet, 10 a.m.                                                                                                                          |          |              |       |            |       |           |
| 14            | "            | 413    | 18·8       | 57 " 55 " 3 p.m.                                                                                                                                               |          |              |       |            |       |           |
| 15            | "            | 424    | 20·4       |                                                                                                                                                                |          |              |       |            |       |           |
| 16            | "            | 462    | 19·8       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·05</td><td>56 10 a.m.</td></tr><tr><td>30·10</td><td>56 3 p.m.</td></tr></table> | Reading. | Temperature. | 30·05 | 56 10 a.m. | 30·10 | 56 3 p.m. |
| Reading.      | Temperature. |        |            |                                                                                                                                                                |          |              |       |            |       |           |
| 30·05         | 56 10 a.m.   |        |            |                                                                                                                                                                |          |              |       |            |       |           |
| 30·10         | 56 3 p.m.    |        |            |                                                                                                                                                                |          |              |       |            |       |           |
| 17            | "            | 463    | 20·2       |                                                                                                                                                                |          |              |       |            |       |           |
| 18            | "            | 470    | 20·2       |                                                                                                                                                                |          |              |       |            |       |           |
| 19            | "            | 475    | 21·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 20            | "            | 447    | 19·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 21            | "            | 450    | 19·8       |                                                                                                                                                                |          |              |       |            |       |           |
| 22            | "            | 468    | 20·0       |                                                                                                                                                                |          |              |       |            |       |           |
|               |              |        |            | October 12, 1864.                                                                                                                                              |          |              |       |            |       |           |
| 1             | 3            | 1,362  | 20·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 2             | "            | 1,386  | 19·2       |                                                                                                                                                                |          |              |       |            |       |           |
| 3             | "            | 1,380  | 20·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 4             | "            | 1,368  | 19·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 5             | "            | 1,386  | 21·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 6             | "            | 1,424  | 20·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 7             | "            | 1,384  | 17·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 8             | "            | 1,360  | 20·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 9             | "            | 1,370  | 19·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 10            | "            | 1,368  | 20·0       | The gun was 58 feet right of line.                                                                                                                             |          |              |       |            |       |           |
| 11            | "            | 1,394  | 19·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 12            | "            | 1,368  | 20·0       | Weather :—Hazy.                                                                                                                                                |          |              |       |            |       |           |
| 13            | "            | 1,394  | 18·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 14            | "            | 1,390  | 19·0       | Wind :—Direction, N.N.W. ; force, 3 ; 10 a.m.                                                                                                                  |          |              |       |            |       |           |
| 15            | "            | 1,430  | 19·0       | " N.W. by N. " 3 ; 3 p.m.                                                                                                                                      |          |              |       |            |       |           |
| 16            | "            | 1,360  | 20·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 17            | "            | 1,424  | 19·0       | Thermometer :—54 dry, 52 wet, 10 a.m.                                                                                                                          |          |              |       |            |       |           |
| 18            | "            | 1,400  | 18·0       | 56 " 54 " 3 p.m.                                                                                                                                               |          |              |       |            |       |           |
| 19            | "            | 1,450  | 20·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 20            | "            | 1,350  | 18·0       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·30</td><td>55 10 a.m.</td></tr><tr><td>30·28</td><td>70 3 p.m.</td></tr></table> | Reading. | Temperature. | 30·30 | 55 10 a.m. | 30·28 | 70 3 p.m. |
| Reading.      | Temperature. |        |            |                                                                                                                                                                |          |              |       |            |       |           |
| 30·30         | 55 10 a.m.   |        |            |                                                                                                                                                                |          |              |       |            |       |           |
| 30·28         | 70 3 p.m.    |        |            |                                                                                                                                                                |          |              |       |            |       |           |
| 21            | "            | 1,335  | 20·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 22            | "            | 1,358  | 19·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 23            | "            | 1,364  | 18·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 24            | "            | 1,332  | 20·2       |                                                                                                                                                                |          |              |       |            |       |           |
| 25            | "            | 1,329  | 20·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 26            | "            | 1,334  | 19·4       |                                                                                                                                                                |          |              |       |            |       |           |
| 27            | "            | 1,372  | 20·2       |                                                                                                                                                                |          |              |       |            |       |           |
| 28            | "            | 1,330  | 17·4       |                                                                                                                                                                |          |              |       |            |       |           |
| 29            | "            | 1,380  | 20·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 30            | "            | 1,330  | 21·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 31            | "            | 1,342  | 16·2       |                                                                                                                                                                |          |              |       |            |       |           |
| 32            | "            | 1,370  | 20·0       |                                                                                                                                                                |          |              |       |            |       |           |
| 33            | "            | 1,374  | 19·4       |                                                                                                                                                                |          |              |       |            |       |           |

## RANGE AND ACCURACY.—SHOT—continued.

| No. of Round.     | Elevation.   | Range. | 1st Graze. | Remarks.                                                                                                                                                       |          |              |       |            |       |           |
|-------------------|--------------|--------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|------------|-------|-----------|
|                   |              |        | Right.     |                                                                                                                                                                |          |              |       |            |       |           |
|                   | °            | Yards. | Yards.     |                                                                                                                                                                |          |              |       |            |       |           |
|                   |              |        |            | October 25, 1864.                                                                                                                                              |          |              |       |            |       |           |
| 1                 | 6            | 2,253  | 36.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 2                 | "            | 2,316  | 28.6       |                                                                                                                                                                |          |              |       |            |       |           |
| 3                 | "            | 2,307  | 33.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 4                 | "            | 2,293  | 33.4       |                                                                                                                                                                |          |              |       |            |       |           |
| 5                 | "            | 2,270  | 28.4       |                                                                                                                                                                |          |              |       |            |       |           |
| 6                 | "            | 2,319  | 29.6       |                                                                                                                                                                |          |              |       |            |       |           |
| 7                 | "            | 2,298  | 28.4       |                                                                                                                                                                |          |              |       |            |       |           |
| 8                 | "            | 2,310  | 30.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 9                 | "            | 2,310  | 32.2       |                                                                                                                                                                |          |              |       |            |       |           |
| 10                | "            | 2,210  | 32.6       |                                                                                                                                                                |          |              |       |            |       |           |
| 11                | "            | 2,159  | 25.6       |                                                                                                                                                                |          |              |       |            |       |           |
| 12                | "            | 2,212  | 29.6       |                                                                                                                                                                |          |              |       |            |       |           |
| 13                | "            | 2,299  | 27.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 14                | "            | 2,283  | 31.8       |                                                                                                                                                                |          |              |       |            |       |           |
| 15                | "            | 2,267  | 26.8       |                                                                                                                                                                |          |              |       |            |       |           |
| 16                | "            | 2,319  | 25.2       | The gun was 58 feet right of line.                                                                                                                             |          |              |       |            |       |           |
| 17                | "            | 2,298  | 25.8       | Weather :—Hazy.                                                                                                                                                |          |              |       |            |       |           |
| 18                | "            | 2,229  | 26.2       | Wind :—Direction, E.S.E. ; force, nil ; 10 a.m.                                                                                                                |          |              |       |            |       |           |
| 19                | "            | 2,262  | 24.4       | " E. " 4 ; 3 p.m.                                                                                                                                              |          |              |       |            |       |           |
| 20                | "            | 2,323  | 32.0       | Thermometer :—52 dry, 52 wet, 10 a.m.                                                                                                                          |          |              |       |            |       |           |
| 21                | "            | 2,390  | 20.8       | 56 " 55 " 3 p.m.                                                                                                                                               |          |              |       |            |       |           |
| 22                | "            | 2,306  | 31.8       |                                                                                                                                                                |          |              |       |            |       |           |
| 23                | "            | 2,111  | 31.8       |                                                                                                                                                                |          |              |       |            |       |           |
| 24                | "            | 2,263  | 27.8       |                                                                                                                                                                |          |              |       |            |       |           |
| 25                | "            | 2,226  | 23.6       |                                                                                                                                                                |          |              |       |            |       |           |
| 26                | "            | 2,250  | 24.6       |                                                                                                                                                                |          |              |       |            |       |           |
| 27                | "            | 2,211  | 22.2       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.55</td><td>52 10 a.m.</td></tr><tr><td>29.45</td><td>56 3 p.m.</td></tr></table> | Reading. | Temperature. | 29.55 | 52 10 a.m. | 29.45 | 56 3 p.m. |
| Reading.          | Temperature. |        |            |                                                                                                                                                                |          |              |       |            |       |           |
| 29.55             | 52 10 a.m.   |        |            |                                                                                                                                                                |          |              |       |            |       |           |
| 29.45             | 56 3 p.m.    |        |            |                                                                                                                                                                |          |              |       |            |       |           |
| 28                | "            | 2,177  | 30.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 29                | "            | 2,255  | 25.6       |                                                                                                                                                                |          |              |       |            |       |           |
| 30                | "            | 2,269  | 31.6       |                                                                                                                                                                |          |              |       |            |       |           |
| 31                | "            | 2,261  | 30.8       |                                                                                                                                                                |          |              |       |            |       |           |
| 32                | "            | 2,223  | 34.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 33                | "            | 2,310  | 31.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 34                | "            | 2,243  | 31.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 35                | "            | 2,180  | 25.2       |                                                                                                                                                                |          |              |       |            |       |           |
| 36                | "            | 2,134  | 29.4       |                                                                                                                                                                |          |              |       |            |       |           |
| 37                | "            | 2,220  | 27.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 38                | "            | 2,210  | 24.8       |                                                                                                                                                                |          |              |       |            |       |           |
| 39                | "            | 2,122  | 28.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 40                | "            | 2,270  | 29.2       |                                                                                                                                                                |          |              |       |            |       |           |
| 41                | "            | 2,334  | 29.2       |                                                                                                                                                                |          |              |       |            |       |           |
| 42                | "            | 2,298  | 31.6       |                                                                                                                                                                |          |              |       |            |       |           |
| 43                | "            | 2,341  | 27.4       |                                                                                                                                                                |          |              |       |            |       |           |
| 44                | "            | 2,374  | 26.8       |                                                                                                                                                                |          |              |       |            |       |           |
| October 26, 1864. |              |        |            |                                                                                                                                                                |          |              |       |            |       |           |
| 1                 | 9            | 3,142  | 40.4       |                                                                                                                                                                |          |              |       |            |       |           |
| 2                 | "            | 3,186  | 37.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 3                 | "            | 3,196  | 37.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 4                 | "            | 3,192  | 35.6       |                                                                                                                                                                |          |              |       |            |       |           |
| 5                 | "            | 3,220  | 37.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 6                 | "            | 3,222  | 35.4       |                                                                                                                                                                |          |              |       |            |       |           |
| 7                 | "            | 3,192  | 46.0       | The gun was 58 feet right of line.                                                                                                                             |          |              |       |            |       |           |
| 8                 | "            | 3,220  | 40.4       | Weather :—Cloudy, 10 a.m.                                                                                                                                      |          |              |       |            |       |           |
| 9                 | "            | 3,210  | 43.2       | Hazy, 3 p.m.                                                                                                                                                   |          |              |       |            |       |           |
| 10                | "            | 3,144  | 41.4       |                                                                                                                                                                |          |              |       |            |       |           |
| 11                | "            | 3,127  | 45.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 12                | "            | 3,112  | 41.4       | Wind :—Direction, E. ; force, 3 ; 10 a.m.                                                                                                                      |          |              |       |            |       |           |
| 13                | "            | 3,146  | 41.2       | " E. by N. " 3 ; 3 p.m.                                                                                                                                        |          |              |       |            |       |           |
| 14                | "            | 3,137  | 40.4       | Thermometer :—54 dry, 54 wet, 10 a.m.                                                                                                                          |          |              |       |            |       |           |
| 15                | "            | 3,109  | 40.4       | 57 " 56 " 3 p.m.                                                                                                                                               |          |              |       |            |       |           |
| 16                | "            | 2,986  | 42.8       |                                                                                                                                                                |          |              |       |            |       |           |
| 17                | "            | 3,075  | 42.4       |                                                                                                                                                                |          |              |       |            |       |           |
| 18                | "            | 3,115  | 41.8       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.38</td><td>55 10 a.m.</td></tr><tr><td>29.30</td><td>55 3 p.m.</td></tr></table> | Reading. | Temperature. | 29.38 | 55 10 a.m. | 29.30 | 55 3 p.m. |
| Reading.          | Temperature. |        |            |                                                                                                                                                                |          |              |       |            |       |           |
| 29.38             | 55 10 a.m.   |        |            |                                                                                                                                                                |          |              |       |            |       |           |
| 29.30             | 55 3 p.m.    |        |            |                                                                                                                                                                |          |              |       |            |       |           |
| 19                | "            | 3,091  | 46.2       |                                                                                                                                                                |          |              |       |            |       |           |
| 20                | "            | 3,116  | 48.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 21                | "            | 3,108  | 47.4       |                                                                                                                                                                |          |              |       |            |       |           |
| 22                | "            | 3,110  | 45.2       |                                                                                                                                                                |          |              |       |            |       |           |
| 23                | "            | 3,094  | 45.8       |                                                                                                                                                                |          |              |       |            |       |           |
| 24                | "            | 3,120  | 44.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 25                | "            | 3,055  | 41.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 26                | "            | 3,087  | 42.0       |                                                                                                                                                                |          |              |       |            |       |           |
| 27                | "            | 3,084  | 39.6       |                                                                                                                                                                |          |              |       |            |       |           |
| 28                | "            | 3,114  | 42.0       |                                                                                                                                                                |          |              |       |            |       |           |

## RANGE AND ACCURACY.—SHOT—continued.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                              |          |              |       |    |
|---------------|--------------|--------|------------|--------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|               |              |        |            | Right. |                                                                                                                       |          |              |       |    |
|               | °            | Yards. | Yards.     |        |                                                                                                                       |          |              |       |    |
| 1             | 12           | 4,011  | 62.0       |        | March 2, 1865.                                                                                                        |          |              |       |    |
| 2             | "            | 4,209  | 54.4       |        |                                                                                                                       |          |              |       |    |
| 3             | "            | 4,228  | 55.0       |        |                                                                                                                       |          |              |       |    |
| 4             | "            | 4,111  | 50.2       |        |                                                                                                                       |          |              |       |    |
| 5             | "            | 4,164  | 56.0       |        | The gun was 59 feet right of line.                                                                                    |          |              |       |    |
| 6             | "            | 3,933  | 64.0       |        |                                                                                                                       |          |              |       |    |
| 7             | "            | 4,137  | 54.6       |        | Weather :—Foggy and raining, 10 a.m.                                                                                  |          |              |       |    |
| 8             | "            | 4,209  | 49.0       |        | Slight haze, 3 p.m.                                                                                                   |          |              |       |    |
| 9             | "            | 4,087  | 47.0       |        |                                                                                                                       |          |              |       |    |
| 10            | "            | 4,049  | 67.0       |        | Wind :—Direction, N.W. by W. ; force 4 ; 10 a.m.                                                                      |          |              |       |    |
| 11            | "            | 4,175  | 44.0       |        | " " N.W. ; " 4 ; 3 p.m.                                                                                               |          |              |       |    |
| 12            | "            | 4,195  | 45.0       |        |                                                                                                                       |          |              |       |    |
| 13            | "            | 4,228  | 45.6       |        | Thermometer :—44 dry, 44 wet, 10 a.m.                                                                                 |          |              |       |    |
| 14            | "            | 4,147  | 46.0       |        | 46 " 45 " 3 p.m.                                                                                                      |          |              |       |    |
| 15            | "            | 4,137  | 53.0       |        |                                                                                                                       |          |              |       |    |
| 16            | "            | 4,180  | 51.0       |        |                                                                                                                       |          |              |       |    |
| 17            | "            | 3,975  | 66.0       |        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.70</td><td>46</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.70 | 46 |
| Reading.      | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 29.70         | 46           |        |            |        |                                                                                                                       |          |              |       |    |
| 18            | "            | 4,077  | 46.2       |        | 29.70 48 3 p.m.                                                                                                       |          |              |       |    |
| 19            | "            | 4,171  | 53.0       |        |                                                                                                                       |          |              |       |    |
| 20            | "            | 4,135  | 64.6       |        |                                                                                                                       |          |              |       |    |
| 21            | "            | 4,145  | 60.4       |        |                                                                                                                       |          |              |       |    |
| 22            | "            | 4,131  | 70.0       |        |                                                                                                                       |          |              |       |    |
|               |              |        |            |        | October 27, 1864.                                                                                                     |          |              |       |    |
| 1             | 15           | 4,965  | 70.6       |        | The gun was 58 feet right of line.                                                                                    |          |              |       |    |
| 2             | "            | 4,956  | 56.2       |        | Weather :—Foggy.                                                                                                      |          |              |       |    |
| 3             | "            | 4,969  | 68.8       |        | Wind :—Direction, N. ; force, 1 ; 10 a.m.                                                                             |          |              |       |    |
| 4             | "            | 4,957  | 56.2       |        | " W. by N. " 2 ; 3 p.m.                                                                                               |          |              |       |    |
| 5             | "            | 4,936  | 64.0       |        | Thermometer :—55 dry, 54 wet, 10 a.m.                                                                                 |          |              |       |    |
| 6             | "            | 3,555  | 14.0       |        | 56 " 56 " 3 p.m.                                                                                                      |          |              |       |    |
| 7             | "            | 4,907  | 62.0       |        |                                                                                                                       |          |              |       |    |
| 8             | "            | 4,798  | 60.2       |        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.28</td><td>56</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.28 | 56 |
| Reading.      | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 29.28         | 56           |        |            |        |                                                                                                                       |          |              |       |    |
|               |              |        |            |        | 29.35 56 3 p.m.                                                                                                       |          |              |       |    |
|               |              |        |            |        | October 28, 1864.                                                                                                     |          |              |       |    |
| 1             | 15           | 4,687  | 82.6       |        | The gun was 58 feet to right of line.                                                                                 |          |              |       |    |
| 2             | "            | 4,697  | 77.0       |        | Weather :—Thick haze on water, 10 a.m.                                                                                |          |              |       |    |
| 3             | "            | 4,671  | 79.0       |        | Slight haze, 3 p.m.                                                                                                   |          |              |       |    |
| 4             | "            | 4,648  | 78.6       |        |                                                                                                                       |          |              |       |    |
| 5             | "            | 4,471  | 69.6       |        | Wind :—Direction, N.E. by E. ; force, 1 ; 10 a.m.                                                                     |          |              |       |    |
| 6             | "            | 4,696  | 75.4       |        | " E. by N. ; " 3 ; 3 p.m.                                                                                             |          |              |       |    |
| 7             | "            | 4,660  | 80.6       |        |                                                                                                                       |          |              |       |    |
| 8             | "            | 4,324  | 98.0       |        | Thermometer :—56 dry, 55 wet, 10 a.m.                                                                                 |          |              |       |    |
| 9             | "            | 4,576  | 72.8       |        | 57 " 56 " 3 p.m.                                                                                                      |          |              |       |    |
| 10            | "            | 4,424  | 86.0       |        |                                                                                                                       |          |              |       |    |
| 11            | "            | 4,626  | 76.0       |        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.55</td><td>58</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.55 | 58 |
| Reading.      | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 29.55         | 58           |        |            |        |                                                                                                                       |          |              |       |    |
| 12            | "            | 4,386  | 69.0       |        | 29.55 57 3 p.m.                                                                                                       |          |              |       |    |
|               |              |        |            |        | June 21, 1865.                                                                                                        |          |              |       |    |
| 1             | 15           | 4,750  | 33.0       |        |                                                                                                                       |          |              |       |    |
| 2             | "            | 4,770  | 15.2       |        |                                                                                                                       |          |              |       |    |
| 3             | "            | 4,844  | 8.6        |        |                                                                                                                       |          |              |       |    |
| 4             | "            | 4,824  | 17.6       |        |                                                                                                                       |          |              |       |    |
| 5             | "            | 4,748  | 4.4        |        |                                                                                                                       |          |              |       |    |
| 6             | "            | 4,780  | 13.6       |        |                                                                                                                       |          |              |       |    |
| 7             | "            | 4,746  | 24.0       |        | Weather :—Clear.                                                                                                      |          |              |       |    |
| 8             | "            | 4,700  | 13.0       |        |                                                                                                                       |          |              |       |    |
| 9             | "            | 4,860  | 14.0       |        | Wind :—Direction, S.E. by S. ; force, 2 ; 10 a.m.                                                                     |          |              |       |    |
| 10            | "            | 4,442  | 16.0       |        | " " " 2 ; 3 p.m.                                                                                                      |          |              |       |    |
| 11            | "            | 4,772  | 21.0       |        |                                                                                                                       |          |              |       |    |
| 12            | "            | 4,704  | 26.4       |        | Thermometer :—67 dry, 64 wet, 10 a.m.                                                                                 |          |              |       |    |
| 13            | "            | 4,747  | 15.0       |        | 70 " 66 " 3 p.m.                                                                                                      |          |              |       |    |
| 14            | "            | 4,675  | 18.0       |        |                                                                                                                       |          |              |       |    |
| 15            | "            | 4,726  | 22.0       |        |                                                                                                                       |          |              |       |    |
| 16            | "            | 4,621  | 29.0       |        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.40</td><td>67</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.40 | 67 |
| Reading.      | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 30.40         | 67           |        |            |        |                                                                                                                       |          |              |       |    |
| 17            | "            | 4,724  | 19.0       |        | 30.40 67 3 p.m.                                                                                                       |          |              |       |    |
| 18            | "            | 4,706  | 27.2       |        |                                                                                                                       |          |              |       |    |
| 19            | "            | 4,686  | 49.0       |        |                                                                                                                       |          |              |       |    |
| 20            | "            | 4,662  | 15.0       |        |                                                                                                                       |          |              |       |    |
| 21            | "            | 4,685  | 31.0       |        |                                                                                                                       |          |              |       |    |
| 22            | "            | 4,778  | 34.0       |        |                                                                                                                       |          |              |       |    |
| 23            | "            | 4,646  | 32.0       |        |                                                                                                                       |          |              |       |    |



## RANGE AND ACCURACY.—SHOT—continued.

| No. of Round. | Elevation.   | Range. | 1st Graze. | Remarks.                                                                                                              |          |              |       |    |
|---------------|--------------|--------|------------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|               |              |        | Right.     |                                                                                                                       |          |              |       |    |
|               | °            | Yards. | Yards.     |                                                                                                                       |          |              |       |    |
| 1             | 21           | 5,602  | 79.0       | November 22, 1864.                                                                                                    |          |              |       |    |
| 2             | "            | 5,800  | 78.4       |                                                                                                                       |          |              |       |    |
| 3             | "            | 5,856  | 85.6       |                                                                                                                       |          |              |       |    |
| 4             | "            | 5,597  | 66.6       |                                                                                                                       |          |              |       |    |
| 5             | "            | 5,772  | 68.0       |                                                                                                                       |          |              |       |    |
| 6             | "            | 5,920  | 73.4       | The gun was 9 feet left of line.                                                                                      |          |              |       |    |
| 7             | "            | 6,032  | 88.0       | Weather :—Hazy and raining, 10 a.m.                                                                                   |          |              |       |    |
| 8             | "            | 5,790  | 74.0       | Clearing up, 3 p.m.                                                                                                   |          |              |       |    |
| 9             | "            | 5,885  | 86.0       | Wind :—Direction, W.S.W. ; force, 3 ; 10 a.m.                                                                         |          |              |       |    |
| 10            | "            | 5,957  | 97.6       | " N.W. by W. " 5 ; 3 p.m.                                                                                             |          |              |       |    |
| 11            | "            | 5,403  | 92.0       | Thermometer :—49 dry, 49 wet, 10 a.m.                                                                                 |          |              |       |    |
| 12            | "            | 5,958  | 94.0       | 49 " 47 " 3 p.m.                                                                                                      |          |              |       |    |
| 13            | "            | 5,815  | 89.4       |                                                                                                                       |          |              |       |    |
| 14            | "            | 5,983  | 90.0       |                                                                                                                       |          |              |       |    |
| 15            | "            | 5,913  | 86.0       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.65</td><td>51</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.65 | 51 |
| Reading.      | Temperature. |        |            |                                                                                                                       |          |              |       |    |
| 29.65         | 51           |        |            |                                                                                                                       |          |              |       |    |
| 16            | "            | 5,490  | 92.0       | 29.55 52 3 p.m.                                                                                                       |          |              |       |    |
| 17            | "            | 5,703  | 70.0       |                                                                                                                       |          |              |       |    |
| 18            | "            | 5,916  | 87.4       |                                                                                                                       |          |              |       |    |
| 19            | "            | 5,485  | 79.0       |                                                                                                                       |          |              |       |    |
| 20            | "            | 5,898  | 85.0       |                                                                                                                       |          |              |       |    |
| 1             | 3            | 1,409  | 26.0       | February 21, 1865.                                                                                                    |          |              |       |    |
| 2             | "            | 1,435  | 24.0       |                                                                                                                       |          |              |       |    |
| 3             | "            | 1,408  | 27.0       |                                                                                                                       |          |              |       |    |
| 4             | "            | 1,422  | 25.6       | The gun was 59 feet right of line.                                                                                    |          |              |       |    |
| 5             | "            | 1,375  | 24.8       |                                                                                                                       |          |              |       |    |
| 6             | "            | 1,425  | 20.6       | Cartridges filled with L.G. powder.                                                                                   |          |              |       |    |
| 7             | "            | 1,412  | 23.6       |                                                                                                                       |          |              |       |    |
| 8             | "            | 1,392  | 24.3       | Weather :—Hazy, 10 a.m.                                                                                               |          |              |       |    |
| 9             | "            | 1,388  | 24.8       | Hazy and snowing, 3 p.m.                                                                                              |          |              |       |    |
| 10            | "            | 1,382  | 25.0       |                                                                                                                       |          |              |       |    |
| 11            | "            | 1,392  | 23.0       | Wind :—Direction, N.W. ; force, 3 ; 10 a.m.                                                                           |          |              |       |    |
| 12            | "            | 1,408  | 24.0       | " W. ; " 3 ; 3 p.m.                                                                                                   |          |              |       |    |
| 13            | "            | 1,316  | 23.8       |                                                                                                                       |          |              |       |    |
| 14            | "            | 1,396  | 25.6       | Thermometer :—32 dry, 31 wet, 10 a.m.                                                                                 |          |              |       |    |
| 15            | "            | 1,420  | 22.8       | 34 " 32 " 3 p.m.                                                                                                      |          |              |       |    |
| 16            | "            | 1,418  | 27.0       |                                                                                                                       |          |              |       |    |
| 17            | "            | 1,407  | 29.0       |                                                                                                                       |          |              |       |    |
| 18            | "            | 1,430  | 26.6       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.38</td><td>37</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.38 | 37 |
| Reading.      | Temperature. |        |            |                                                                                                                       |          |              |       |    |
| 30.38         | 37           |        |            |                                                                                                                       |          |              |       |    |
| 19            | "            | 1,436  | 27.4       | 30.30 39 3 p.m.                                                                                                       |          |              |       |    |
| 20            | "            | 1,422  | 28.6       |                                                                                                                       |          |              |       |    |
| 21            | "            | 1,413  | 27.0       |                                                                                                                       |          |              |       |    |
| 22            | "            | 1,443  | 24.0       |                                                                                                                       |          |              |       |    |
| 1             | 6            | 2,315  | 31.0       | March 10, 1865                                                                                                        |          |              |       |    |
| 2             | "            | 2,324  | 35.0       |                                                                                                                       |          |              |       |    |
| 3             | "            | 2,474  | 30.0       |                                                                                                                       |          |              |       |    |
| 4             | "            | 2,489  | 28.0       |                                                                                                                       |          |              |       |    |
| 5             | "            | 2,490  | 28.6       |                                                                                                                       |          |              |       |    |
| 6             | "            | 2,488  | 31.4       |                                                                                                                       |          |              |       |    |
| 7             | "            | 2,491  | 27.4       |                                                                                                                       |          |              |       |    |
| 8             | "            | 2,502  | 32.0       | The gun was 59 feet right of line.                                                                                    |          |              |       |    |
| 9             | "            | 2,459  | 26.4       |                                                                                                                       |          |              |       |    |
| 10            | "            | 2,461  | 30.4       |                                                                                                                       |          |              |       |    |
| 11            | "            | 2,495  | 30.0       |                                                                                                                       |          |              |       |    |
| 12            | "            | 2,465  | 21.6       | Cartridges filled with L.G. powder.                                                                                   |          |              |       |    |
| 13            | "            | 2,481  | 21.4       |                                                                                                                       |          |              |       |    |
| 14            | "            | 2,440  | 25.2       |                                                                                                                       |          |              |       |    |
| 15            | "            | 2,481  | 24.0       |                                                                                                                       |          |              |       |    |
| 16            | "            | 2,460  | 31.0       |                                                                                                                       |          |              |       |    |
| 17            | "            | 2,500  | 21.6       |                                                                                                                       |          |              |       |    |
| 18            | "            | 2,472  | 21.0       |                                                                                                                       |          |              |       |    |
| 19            | "            | 2,507  | 25.0       |                                                                                                                       |          |              |       |    |
| 20            | "            | 2,340  | 20.0       |                                                                                                                       |          |              |       |    |
| 21            | "            | 2,495  | 20.0       |                                                                                                                       |          |              |       |    |
| 22            | "            | 2,475  | 31.2       |                                                                                                                       |          |              |       |    |

RANGE AND ACCURACY.—SHOT—*continued.*

AFTER FIRING 3,000 ROUNDS.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | Right.     | Left.  |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
|               | °            | Yards. | Yards.     | Yards. |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 1             | 6            | 2,330  | 9·8        | —      | June 19, 1865.                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 2             | "            | 2,317  | 8·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 3             | "            | 2,291  | 10·0       | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 4             | "            | 2,374  | 11·4       | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 5             | "            | 2,333  | 8·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 6             | "            | 2,323  | 11·0       | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 7             | "            | 2,366  | 10·6       | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 8             | "            | 2,320  | 14·4       | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 9             | "            | 2,360  | 12·0       | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 10            | "            | 2,248  | 12·0       | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 11            | "            | 2,319  | 9·0        | —      | Weather:—Clear.<br><br>Wind:—Direction, E.N.E.; force, 2; 10 a.m.<br>,, S.E. by E.   ,, 2; 3 p.m.<br><br>Thermometer:—56 dry, 54 wet, 10 a.m.<br>61   ,, 59   ,, 3 p.m.<br><br>Barometer:— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29·90</td><td>58</td></tr><tr><td>30·35</td><td>60</td></tr></table> 10 a.m.<br>3 p.m. | Reading. | Temperature. | 29·90 | 58 | 30·35 | 60 |
| Reading.      | Temperature. |        |            |        |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 29·90         | 58           |        |            |        |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 30·35         | 60           |        |            |        |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 12            | "            | 2,296  | 11·4       | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 13            | "            | 2,345  | 9·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 14            | "            | 2,320  | 8·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 15            | "            | 2,321  | 9·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 16            | "            | 2,386  | 8·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 17            | "            | 2,370  | 6·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 18            | "            | 2,360  | 6·4        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 19            | "            | 2,344  | 6·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 20            | "            | 2,262  | 6·8        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 21            | "            | 2,314  | 4·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 22            | "            | 2,322  | 3·2        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 23            | "            | 2,308  | 3·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 24            | "            | 2,302  | 4·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 25            | "            | 2,350  | 2·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 26            | "            | 2,273  | 2·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 27            | "            | 2,288  | 3·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 28            | "            | 2,296  | 2·4        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 29            | "            | 2,338  | 1·4        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 30            | "            | 2,318  | 1·6        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 31            | "            | 2,246  | 4·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 32            | "            | 2,335  | 1·4        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |
| 33            | "            | 2,325  | 6·0        | —      |                                                                                                                                                                                                                                                                                                                                                 |          |              |       |    |       |    |



COMMON SHELL (WEIGHTED WITH SAND).

PARTICULARS OF SHELL AND AMMUNITION.

N.B.—The figures in *Italics* are the rounds struck out by the competitors as abnormal shots.

SHOEBURYNESS.

*Projectile.*

Nature, common shell.  
Weight, 68 $\frac{3}{4}$  lbs.  
Diameter, 6·43 inches.

Length, 14·66 inches.  
Bursting charge, 4·8 lbs.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | Right.     | Left.  |                                                                                                                                                         |          |              |       |    |       |    |
|               | °            | Yards. | Yards.     | Yards. | November 8, 1864.                                                                                                                                       |          |              |       |    |       |    |
| 1             | 1            | 705    | —          | 5·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "            | 743    | —          | 4·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 750    | —          | 4·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "            | 754    | —          | 4·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "            | 747    | —          | 5·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 6             | "            | 721    | —          | 4·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 7             | "            | 696    | —          | 4·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 8             | "            | 714    | —          | 4·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 9             | "            | 744    | —          | 5·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 10            | "            | 735    | —          | 5·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 11            | "            | 720    | —          | 5·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "            | 729    | —          | 5·0    | The gun 'was 9 feet left of line.                                                                                                                       |          |              |       |    |       |    |
| 13            | "            | 690    | —          | 4·4    | Weather :—Thick haze, 10 a.m.                                                                                                                           |          |              |       |    |       |    |
| 14            | "            | 730    | —          | 4·8    | Foggy, 3 p.m.                                                                                                                                           |          |              |       |    |       |    |
| 15            | "            | 699    | —          | 4·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 16            | "            | 725    | —          | 4·6    | Wind :—Direction, N.N.W. ; force, 3 ; 10 a.m.                                                                                                           |          |              |       |    |       |    |
| 17            | "            | 701    | —          | 4·6    | " " N. " 1 ; 3 p.m.                                                                                                                                     |          |              |       |    |       |    |
| 18            | "            | 690    | —          | 4·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 19            | "            | 713    | —          | 4·8    | Thermometer :—39 dry, 38 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 20            | "            | 736    | —          | 4·6    | 45 " 44 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 21            | "            | 707    | —          | 5·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 22            | "            | 697    | —          | 5·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 23            | "            | 703    | —          | 4·8    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·10</td><td>43</td></tr><tr><td>30·08</td><td>46</td></tr></table> 10 a.m. | Reading. | Temperature. | 30·10 | 43 | 30·08 | 46 |
| Reading.      | Temperature. |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·10         | 43           |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·08         | 46           |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 24            | "            | 678    | —          | 4·2    | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 25            | "            | 692    | —          | 4·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 26            | "            | 694    | —          | 2·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 27            | "            | 694    | —          | 4·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 28            | "            | 690    | —          | 3·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 29            | "            | 701    | —          | 4·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 30            | "            | 696    | —          | 3·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 31            | "            | 711    | —          | 3·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 32            | "            | 695    | —          | 4·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 33            | "            | 719    | —          | 4·8    |                                                                                                                                                         |          |              |       |    |       |    |

RANGE AND ACCURACY.—COMMON SHELL—*continued.*

| No. of Round.      | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                              |          |              |       |    |
|--------------------|--------------|--------|------------|--------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|                    |              |        | Right.     | Left.  |                                                                                                                       |          |              |       |    |
|                    | °            | Yards. | Yards.     | Yards. | November 22, 1864.                                                                                                    |          |              |       |    |
| 1                  | 4            | 1,564  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 2                  | "            | 1,544  | 15.0       | —      |                                                                                                                       |          |              |       |    |
| 3                  | "            | 1,570  | 16.0       | —      |                                                                                                                       |          |              |       |    |
| 4                  | "            | 1,590  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 5                  | "            | 1,590  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 6                  | "            | 1,576  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 7                  | "            | 1,540  | 16.0       | —      |                                                                                                                       |          |              |       |    |
| 8                  | "            | 1,568  | 12.0       | —      |                                                                                                                       |          |              |       |    |
| 9                  | "            | 1,496  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 10                 | "            | 1,496  | 14.0       | —      | The gun was 39 feet right of line.                                                                                    |          |              |       |    |
| 11                 | "            | 1,510  | 13.0       | —      |                                                                                                                       |          |              |       |    |
| 12                 | "            | 1,596  | 12.4       | —      | Weather :—Hazy and raining, 10 a.m.                                                                                   |          |              |       |    |
| 13                 | "            | 1,584  | 13.0       | —      | Clearing up, 3 p.m.                                                                                                   |          |              |       |    |
| 14                 | "            | 1,560  | 12.0       | —      |                                                                                                                       |          |              |       |    |
| 15                 | "            | 1,540  | 15.0       | —      | Wind :—Direction, W.S.W.; force, 3; 10 a.m.                                                                           |          |              |       |    |
| 16                 | "            | 1,538  | 14.4       | —      | " N.W. by W. " 5; 3 p.m.                                                                                              |          |              |       |    |
| 17                 | "            | 1,564  | 16.0       | —      |                                                                                                                       |          |              |       |    |
| 18                 | "            | 1,588  | 11.2       | —      | Thermometer :—49 dry, 49 wet, 10 a.m.                                                                                 |          |              |       |    |
| 19                 | "            | 1,562  | 12.0       | —      | 49 " 47 " 3 p.m.                                                                                                      |          |              |       |    |
| 20                 | "            | 1,552  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 21                 | "            | 1,536  | 12.0       | —      |                                                                                                                       |          |              |       |    |
| 22                 | "            | 1,546  | 12.2       | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.65</td><td>51</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.65 | 51 |
| Reading.           | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 29.65              | 51           |        |            |        |                                                                                                                       |          |              |       |    |
| 23                 | "            | 1,504  | 11.2       | —      | 29.55 52 3 p.m.                                                                                                       |          |              |       |    |
| 24                 | "            | 1,556  | 12.0       | —      |                                                                                                                       |          |              |       |    |
| 25                 | "            | 1,500  | 11.4       | —      |                                                                                                                       |          |              |       |    |
| 26                 | "            | 1,514  | 13.0       | —      |                                                                                                                       |          |              |       |    |
| 27                 | "            | 1,530  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 28                 | "            | 1,545  | 16.0       | —      |                                                                                                                       |          |              |       |    |
| 29                 | "            | 1,450  | 15.4       | —      |                                                                                                                       |          |              |       |    |
| 30                 | "            | 1,562  | 11.4       | —      |                                                                                                                       |          |              |       |    |
| 31                 | "            | 1,517  | 10.4       | —      |                                                                                                                       |          |              |       |    |
| 32                 | "            | 1,540  | 17.0       | —      |                                                                                                                       |          |              |       |    |
| 33                 | "            | 1,506  | 10.0       | —      |                                                                                                                       |          |              |       |    |
| November 21, 1864. |              |        |            |        |                                                                                                                       |          |              |       |    |
| 1                  | 7            | 2,513  | 19.4       | —      |                                                                                                                       |          |              |       |    |
| 2                  | "            | 2,566  | 22.2       | —      |                                                                                                                       |          |              |       |    |
| 3                  | "            | 2,600  | 23.6       | —      |                                                                                                                       |          |              |       |    |
| 4                  | "            | 2,769  | 23.8       | —      |                                                                                                                       |          |              |       |    |
| 5                  | "            | 2,578  | 23.6       | —      |                                                                                                                       |          |              |       |    |
| 6                  | "            | 2,630  | 22.0       | —      |                                                                                                                       |          |              |       |    |
| 7                  | "            | 2,654  | 22.6       | —      |                                                                                                                       |          |              |       |    |
| 8                  | "            | 2,704  | 22.8       | —      |                                                                                                                       |          |              |       |    |
| 9                  | "            | 2,625  | 22.6       | —      |                                                                                                                       |          |              |       |    |
| 10                 | "            | 2,612  | 22.6       | —      |                                                                                                                       |          |              |       |    |
| 11                 | "            | 2,615  | 22.6       | —      |                                                                                                                       |          |              |       |    |
| 12                 | "            | 2,590  | 22.4       | —      |                                                                                                                       |          |              |       |    |
| 13                 | "            | 2,531  | 20.8       | —      |                                                                                                                       |          |              |       |    |
| 14                 | "            | 2,590  | 20.0       | —      | The gun was 39 feet right of line.                                                                                    |          |              |       |    |
| 15                 | "            | 2,592  | 23.0       | —      |                                                                                                                       |          |              |       |    |
| 16                 | "            | 2,670  | 21.0       | —      | Weather :—Hazy.                                                                                                       |          |              |       |    |
| 17                 | "            | 2,494  | 18.0       | —      |                                                                                                                       |          |              |       |    |
| 18                 | "            | 2,474  | 18.8       | —      | Wind :—Direction, N.W. by W.; force, 2; 10 a.m.                                                                       |          |              |       |    |
| 19                 | "            | 2,564  | 20.0       | —      | " S.W. by W. " 3; 3 p.m.                                                                                              |          |              |       |    |
| 20                 | "            | 2,584  | 20.4       | —      |                                                                                                                       |          |              |       |    |
| 21                 | "            | 2,579  | 17.8       | —      | Thermometer :—45 dry, 44 wet, 10 a.m.                                                                                 |          |              |       |    |
| 22                 | "            | 2,472  | 18.6       | —      | 49 " 48 " 3 p.m.                                                                                                      |          |              |       |    |
| 23                 | "            | 2,475  | 20.0       | —      |                                                                                                                       |          |              |       |    |
| 24                 | "            | 2,372  | 16.8       | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.88</td><td>49</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.88 | 49 |
| Reading.           | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 29.88              | 49           |        |            |        |                                                                                                                       |          |              |       |    |
| 25                 | "            | 2,550  | 19.6       | —      | 29.90 51 3 p.m.                                                                                                       |          |              |       |    |
| 26                 | "            | 2,494  | 20.4       | —      |                                                                                                                       |          |              |       |    |
| 27                 | "            | 2,545  | 19.6       | —      |                                                                                                                       |          |              |       |    |
| 28                 | "            | 2,509  | 19.4       | —      |                                                                                                                       |          |              |       |    |
| 29                 | "            | 2,375  | 19.8       | —      |                                                                                                                       |          |              |       |    |
| 30                 | "            | 2,570  | 24.8       | —      |                                                                                                                       |          |              |       |    |
| 31                 | "            | 2,600  | 23.0       | —      |                                                                                                                       |          |              |       |    |
| 32                 | "            | 2,593  | 20.6       | —      |                                                                                                                       |          |              |       |    |
| 33                 | "            | 2,616  | 23.8       | —      |                                                                                                                       |          |              |       |    |
| 34                 | "            | 2,623  | 23.6       | —      |                                                                                                                       |          |              |       |    |
| 35                 | "            | 2,636  | 23.2       | —      |                                                                                                                       |          |              |       |    |
| 36                 | "            | 2,607  | 21.6       | —      |                                                                                                                       |          |              |       |    |
| 37                 | "            | 2,636  | 22.6       | —      |                                                                                                                       |          |              |       |    |
| 38                 | "            | 2,585  | 27.8       | —      |                                                                                                                       |          |              |       |    |

RANGE AND ACCURACY.—COMMON SHELL—*continued.*

| No. of Round. | Elevation. | Range. | 1st Graze. |        | Remarks.                                          |
|---------------|------------|--------|------------|--------|---------------------------------------------------|
|               |            |        | Right.     | Left.  |                                                   |
|               | °          | Yards. | Yards.     | Yards. | <i>November 10, 1864.</i>                         |
| 1             | 10         | 3,212  | 32.0       | —      |                                                   |
| 2             | "          | 3,396  | 31.6       | —      |                                                   |
| 3             | "          | 3,424  | 33.0       | —      |                                                   |
| 4             | "          | 3,432  | 29.0       | —      |                                                   |
| 5             | "          | 3,403  | 32.6       | —      |                                                   |
| 6             | "          | 3,332  | 36.6       | —      |                                                   |
| 7             | "          | 3,344  | 29.0       | —      | To correspond with Whitworth, broke up.           |
| 8             | "          | 3,398  | 30.0       | —      |                                                   |
| 9             | "          | 3,380  | 33.6       | —      | The gun was in line.                              |
| 10            | "          | 3,397  | 32.0       | —      |                                                   |
| 11            | "          | 3,388  | 29.0       | —      | Weather :—Clear.                                  |
| 12            | "          | 3,356  | 30.6       | —      |                                                   |
| 13            | "          | 3,360  | 29.0       | —      | Wind :—Direction, E.S.E. ; force, 5 ; 10 a.m.     |
| 14            | "          | 3,412  | 30.0       | —      | " E. by S. " 3 ; 3 p.m.                           |
| 15            | "          | 3,396  | 29.4       | —      |                                                   |
| 16            | "          | 3,348  | 26.0       | —      | Thermometer :—43 dry, 41 wet, 10 a.m.             |
| 17            | "          | 3,358  | 31.0       | —      | 43 " 41 " 3 p.m.                                  |
| 18            | "          | 3,244  | 26.0       | —      |                                                   |
| 19            | "          | 3,285  | 29.0       | —      | Reading. Temperature.                             |
| 20            | "          | 3,358  | 31.0       | —      | Barometer :—30.10 47 10 a.m.                      |
| 21            | "          | 3,294  | 28.6       | —      | 30.05 46 3 p.m.                                   |
| 22            | "          | 3,362  | 33.6       | —      | Gun sponged out, and the sponge was used every    |
| 23            | "          | 3,314  | 29.6       | —      | four rounds after.                                |
| 24            | "          | 3,290  | 28.0       | —      |                                                   |
| 25            | "          | 3,348  | 24.0       | —      |                                                   |
| 26            | "          | 3,337  | 30.6       | —      |                                                   |
| 27            | "          | 3,184  | 32.6       | —      |                                                   |
| 28            | "          | 3,148  | 26.0       | —      |                                                   |
| 29            | "          | 3,250  | 28.0       | —      |                                                   |
| 30            | "          | 3,284  | 30.6       | —      |                                                   |
| 31            | "          | 3,342  | 32.0       | —      |                                                   |
| 32            | "          | 3,295  | 24.6       | —      |                                                   |
|               |            |        |            |        | <i>November 21, 1864.</i>                         |
| 1             | 17         | 4,984  | 31.0       | —      |                                                   |
| 2             | "          | 5,040  | 42.0       | —      |                                                   |
| 3             | "          | 5,104  | 43.0       | —      |                                                   |
| 4             | "          | 5,114  | 52.0       | —      | The gun was 9 feet left of line.                  |
| 5             | "          | 5,048  | 40.0       | —      |                                                   |
| 6             | "          | 5,112  | 51.0       | —      | Weather :—Hazy, 10 a.m.                           |
| 7             | "          | 5,055  | 45.0       | —      | " 3 p.m.                                          |
| 8             | "          | 5,080  | 41.0       | —      |                                                   |
| 9             | "          | 5,020  | 40.0       | —      | Wind :—Direction, N.W. by W. ; force, 2 ; 10 a.m. |
| 10            | "          | 5,022  | 45.0       | —      | " S.W. by W. " 3 ; 3 p.m.                         |
| 11            | "          | 5,054  | 51.0       | —      |                                                   |
| 12            | "          | 5,075  | 52.0       | —      | Thermometer :—45 dry, 44 wet, 10 a.m.             |
| 13            | "          | 5,024  | 54.0       | —      | 49 " 48 " 3 p.m.                                  |
| 14            | "          | 4,074  | 45.0       | —      |                                                   |
| 15            | "          | 5,080  | 55.0       | —      | Reading. Temperature.                             |
| 16            | "          | 5,002  | 31.0       | —      | Barometer :—29.88 49 10 a.m.                      |
| 17            | "          | 4,800  | 31.0       | —      | 29.90 51 3 p.m.                                   |
| 18            | "          | 4,868  | 40.0       | —      |                                                   |
| 19            | "          | 5,000  | 41.0       | —      |                                                   |
| 20            | "          | 5,042  | 42.0       | —      |                                                   |

RANGE AND ACCURACY—*continued*.

## SEGMENT SHELL (WEIGHTED WITH SAND.)

## PARTICULARS OF SHELL AND AMMUNITION.

Nature, segment shell.  
Weight, 77.6 lbs.  
Diameter, 6.43 inches.

Length, 13.85 inches.  
No. of segments, 112.  
Bursting charge, 1 lb.

| No of Rounds. | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                          |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | In Line.   | Right. | Left.  |                                                                                                                                                                   |          |              |       |    |       |    |
|               | °            | Yards. |            | Yards. | Yards. |                                                                                                                                                                   |          |              |       |    |       |    |
| 1             | 2            | 978    | —          | 18.2   | —      | October 11, 1864.                                                                                                                                                 |          |              |       |    |       |    |
| 2             | "            | 1,041  | —          | 19.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 3             | "            | 1,028  | —          | 19.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 4             | "            | 1,055  | —          | 21.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 5             | "            | 1,016  | —          | 18.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 6             | "            | 1,024  | —          | 19.6   | —      | The gun was 58 feet right of line.                                                                                                                                |          |              |       |    |       |    |
| 7             | "            | 1,016  | —          | 19.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 8             | "            | 1,011  | —          | 19.8   | —      | Weather :— Thick haze.                                                                                                                                            |          |              |       |    |       |    |
| 9             | "            | 1,016  | —          | 18.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 10            | "            | 1,041  | —          | 15.6   | —      | Wind :—Direction, N. ; force, 2 ; 10 a.m.<br>" " " 2 ; 3 p.m.                                                                                                     |          |              |       |    |       |    |
| 11            | "            | 1,016  | —          | 18.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 12            | "            | 1,033  | —          | 19.4   | —      | Thermometer :—52 dry, 50 wet, 10 a.m.<br>55 " 52 " 3 p.m.                                                                                                         |          |              |       |    |       |    |
| 13            | "            | 1,008  | —          | 17.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 14            | "            | 1,047  | —          | 19.2   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.42</td><td>54</td></tr><tr><td>30.45</td><td>68</td></tr></table> 10 a.m.<br>3 p.m. | Reading. | Temperature. | 30.42 | 54 | 30.45 | 68 |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 30.42         | 54           |        |            |        |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 30.45         | 68           |        |            |        |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 15            | "            | 1,027  | —          | 19.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 16            | "            | 1,013  | —          | 19.2   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 17            | "            | 1,035  | —          | 18.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 18            | "            | 1,031  | —          | 19.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 19            | "            | 1,023  | —          | 18.8   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 20            | "            | 985    | —          | 18.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 21            | "            | 1,050  | —          | 19.2   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 22            | "            | 1,021  | —          | 18.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 23            | "            | 1,016  | —          | 18.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 24            | "            | 955    | —          | 18.0   | —      | Corresponding round, Whitworth, broke up.                                                                                                                         |          |              |       |    |       |    |
| 25            | "            | 978    | —          | 19.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 26            | "            | 997    | —          | 20.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 27            | "            | 984    | —          | 19.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 28            | "            | 990    | —          | 19.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 29            | "            | 990    | —          | 19.2   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 30            | "            | 1,011  | —          | 19.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 31            | "            | 1,010  | —          | 18.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 32            | "            | 984    | —          | 19.8   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 33            | "            | 1,018  | —          | 19.8   | —      | Corresponding round, Whitworth, broke up.                                                                                                                         |          |              |       |    |       |    |
| 34            | "            | 984    | —          | 19.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 35            | "            | 1,013  | —          | 18.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 36            | "            | 978    | —          | 20.8   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 37            | "            | 968    | —          | 19.0   | —      | Corresponding round, Whitworth, not fired.                                                                                                                        |          |              |       |    |       |    |

RANGE AND ACCURACY.—SEGMENT SHELL—*continued.*

| No. of Rounds.    | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                              |          |              |       |    |
|-------------------|--------------|--------|------------|--------|--------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|                   |              |        | In Line.   | Right. | Left.  |                                                                                                                       |          |              |       |    |
| November 9, 1864. |              |        |            |        |        |                                                                                                                       |          |              |       |    |
|                   | °            | Yards. |            | Yards. | Yards. |                                                                                                                       |          |              |       |    |
| 1                 | 5            | 1,995  | —          | 0.6    | —      | The gun was 9 feet left of line.                                                                                      |          |              |       |    |
| 2                 | "            | 2,006  | —          | —      | 3.0    | Weather :—Clear.                                                                                                      |          |              |       |    |
| 3                 | "            | 1,978  | —          | —      | 1.4    | Wind :—Direction, N.E. by E. ; force, 3 ; 10 a.m.                                                                     |          |              |       |    |
| 4                 | "            | 1,960  | —          | —      | 3.6    | " E. by N. ; " 4 ; 3 p.m.                                                                                             |          |              |       |    |
| 5                 | "            | 1,922  | —          | 2.0    | —      |                                                                                                                       |          |              |       |    |
| 6                 | "            | 1,925  | —          | 2.8    | —      | Thermometer :—42 dry, 41 wet, 10 a.m.                                                                                 |          |              |       |    |
| 7                 | "            | 1,912  | Yes.       | —      | —      | 46 " 43 " 3 p.m.                                                                                                      |          |              |       |    |
| 3                 | "            | 1,948  | —          | 1.6    | —      |                                                                                                                       |          |              |       |    |
| 9                 | "            | 1,947  | —          | —      | 3.4    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.15</td><td>44</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.15 | 44 |
| Reading.          | Temperature. |        |            |        |        |                                                                                                                       |          |              |       |    |
| 30.15             | 44           |        |            |        |        |                                                                                                                       |          |              |       |    |
| 10                | "            | 1,961  | —          | —      | 3.0    | 30.12 46 3 p.m.                                                                                                       |          |              |       |    |
| 11                | "            | 1,913  | —          | —      | 2.0    |                                                                                                                       |          |              |       |    |
| 12                | "            | 1,939  | —          | —      | 2.0    |                                                                                                                       |          |              |       |    |
| 13                | "            | 1,932  | —          | —      | 0.2    | Corresponding round, Whitworth, broke up.                                                                             |          |              |       |    |
| 14                | "            | 1,958  | —          | 0.4    | —      | Ditto ditto.                                                                                                          |          |              |       |    |
| 15                | "            | 1,926  | Yes.       | —      | —      | Ditto ditto.                                                                                                          |          |              |       |    |
| 16                | "            | 1,908  | —          | —      | 1.6    |                                                                                                                       |          |              |       |    |
| 17                | "            | 1,907  | —          | —      | 4.0    |                                                                                                                       |          |              |       |    |
| 18                | "            | 1,882  | —          | —      | 3.0    |                                                                                                                       |          |              |       |    |
| 19                | "            | 1,910  | —          | —      | 1.6    |                                                                                                                       |          |              |       |    |
| 20                | "            | 1,867  | —          | 0.4    | —      | Ditto ditto.                                                                                                          |          |              |       |    |
| 21                | "            | 1,876  | —          | —      | 0.4    | Ditto ditto.                                                                                                          |          |              |       |    |
| 22                | "            | 1,874  | —          | 2.0    | —      |                                                                                                                       |          |              |       |    |
| 23                | "            | 1,698  | —          | 7.6    | —      | Ditto ditto.                                                                                                          |          |              |       |    |
| 24                | "            | 1,911  | —          | 2.0    | —      |                                                                                                                       |          |              |       |    |
| 25                | "            | 1,887  | —          | —      | 1.0    | Ditto ditto.                                                                                                          |          |              |       |    |
| October 13, 1864. |              |        |            |        |        |                                                                                                                       |          |              |       |    |
| 1                 | 8            | 2,754  | —          | 36.0   | —      |                                                                                                                       |          |              |       |    |
| 2                 | "            | 2,942  | —          | 36.6   | —      | The gun was 58 feet right of line.                                                                                    |          |              |       |    |
| 3                 | "            | 2,860  | —          | 34.8   | —      |                                                                                                                       |          |              |       |    |
| 4                 | "            | 2,824  | —          | 36.2   | —      | Weather :—Clear, 10 a.m.                                                                                              |          |              |       |    |
| 5                 | "            | 2,788  | —          | 39.4   | —      | Thick haze, 3 p.m.                                                                                                    |          |              |       |    |
| 6                 | "            | 2,858  | —          | 35.0   | —      |                                                                                                                       |          |              |       |    |
| *7                | "            | 2,788  | —          | 38.8   | —      |                                                                                                                       |          |              |       |    |
| 8                 | "            | 2,822  | —          | 37.2   | —      | Wind :—Direction, N. by W. ; force, 3 ; 10 a.m.                                                                       |          |              |       |    |
| 9                 | "            | 2,796  | —          | 32.8   | —      | " N.N.W ; " 2 ; 3 p.m.                                                                                                |          |              |       |    |
| 10                | "            | 2,703  | —          | 37.6   | —      |                                                                                                                       |          |              |       |    |
| 11                | "            | 2,837  | —          | 35.4   | —      | Thermometer :—53 dry, 51 wet, 10 a.m.                                                                                 |          |              |       |    |
| *12               | "            | 2,840  | —          | 35.4   | —      | 59 " 55 " 3 p.m.                                                                                                      |          |              |       |    |
| 13                | "            | 2,790  | —          | 34.2   | —      |                                                                                                                       |          |              |       |    |
| 14                | "            | 2,768  | —          | 37.2   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.10</td><td>60</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.10 | 60 |
| Reading.          | Temperature. |        |            |        |        |                                                                                                                       |          |              |       |    |
| 30.10             | 60           |        |            |        |        |                                                                                                                       |          |              |       |    |
| *15               | "            | 2,833  | —          | 35.6   | —      | 30.10 60 3 p.m.                                                                                                       |          |              |       |    |
| 16                | "            | 2,810  | —          | 38.6   | —      |                                                                                                                       |          |              |       |    |
| 17                | "            | 2,775  | —          | 38.6   | —      |                                                                                                                       |          |              |       |    |
| 18                | "            | 2,832  | —          | 32.2   | —      | *Corresponding rounds, Whitworth, broke up.                                                                           |          |              |       |    |
| 19                | "            | 2,838  | —          | 32.0   | —      |                                                                                                                       |          |              |       |    |
| 20                | "            | 2,759  | —          | 30.6   | —      |                                                                                                                       |          |              |       |    |
| 21                | "            | 2,387  | —          | 30.0   | —      |                                                                                                                       |          |              |       |    |
| 22                | "            | 2,747  | —          | 30.4   | —      |                                                                                                                       |          |              |       |    |
| 23                | "            | 2,661  | —          | 32.2   | —      |                                                                                                                       |          |              |       |    |
| 24                | "            | 2,846  | —          | 33.4   | —      |                                                                                                                       |          |              |       |    |
| 25                | "            | 2,815  | —          | 30.0   | —      |                                                                                                                       |          |              |       |    |



RANGE AND ACCURACY.—SHOT—*continued.*

| No. of Round. | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                              |          |              |       |    |
|---------------|--------------|--------|------------|--------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|               |              |        |            | Right. |                                                                                                                       |          |              |       |    |
|               | 0            | Yards. | Yards.     |        |                                                                                                                       |          |              |       |    |
| 1             | 12           | 4,011  | 62.0       |        | March 2, 1865.                                                                                                        |          |              |       |    |
| 2             | "            | 4,209  | 54.4       |        |                                                                                                                       |          |              |       |    |
| 3             | "            | 4,228  | 55.0       |        |                                                                                                                       |          |              |       |    |
| 4             | "            | 4,111  | 50.2       |        |                                                                                                                       |          |              |       |    |
| 5             | "            | 4,164  | 56.0       |        | The gun was 59 feet right of line.                                                                                    |          |              |       |    |
| 6             | "            | 3,933  | 64.0       |        |                                                                                                                       |          |              |       |    |
| 7             | "            | 4,137  | 54.6       |        | Weather :—Foggy and raining, 10 a.m.                                                                                  |          |              |       |    |
| 8             | "            | 4,209  | 49.0       |        | Slight haze, 3 p.m.                                                                                                   |          |              |       |    |
| 9             | "            | 4,087  | 47.0       |        |                                                                                                                       |          |              |       |    |
| 10            | "            | 4,049  | 67.0       |        | Wind :—Direction, N.W. by W. ; force 4 ; 10 a.m.                                                                      |          |              |       |    |
| 11            | "            | 4,175  | 44.0       |        | " " N.W. ; " 4 ; 3 p.m.                                                                                               |          |              |       |    |
| 12            | "            | 4,195  | 45.0       |        |                                                                                                                       |          |              |       |    |
| 13            | "            | 4,228  | 45.6       |        | Thermometer :—44 dry, 44 wet, 10 a.m.                                                                                 |          |              |       |    |
| 14            | "            | 4,147  | 46.0       |        | 46 " 45 " 3 p.m.                                                                                                      |          |              |       |    |
| 15            | "            | 4,137  | 53.0       |        |                                                                                                                       |          |              |       |    |
| 16            | "            | 4,180  | 51.0       |        |                                                                                                                       |          |              |       |    |
| 17            | "            | 3,975  | 66.0       |        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.70</td><td>46</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.70 | 46 |
| Reading.      | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 29.70         | 46           |        |            |        |                                                                                                                       |          |              |       |    |
| 18            | "            | 4,077  | 46.2       |        | 29.70 48 3 p.m.                                                                                                       |          |              |       |    |
| 19            | "            | 4,171  | 53.0       |        |                                                                                                                       |          |              |       |    |
| 20            | "            | 4,135  | 64.6       |        |                                                                                                                       |          |              |       |    |
| 21            | "            | 4,145  | 60.4       |        |                                                                                                                       |          |              |       |    |
| 22            | "            | 4,131  | 70.0       |        |                                                                                                                       |          |              |       |    |
|               |              |        |            |        | October 27, 1864.                                                                                                     |          |              |       |    |
| 1             | 15           | 4,965  | 70.6       |        | The gun was 58 feet right of line.                                                                                    |          |              |       |    |
| 2             | "            | 4,956  | 56.2       |        | Weather :—Foggy.                                                                                                      |          |              |       |    |
| 3             | "            | 4,969  | 68.8       |        | Wind :—Direction, N. ; force, 1 ; 10 a.m.                                                                             |          |              |       |    |
| 4             | "            | 4,957  | 56.2       |        | " W. by N. " 2 ; 3 p.m.                                                                                               |          |              |       |    |
| 5             | "            | 4,936  | 64.0       |        | Thermometer :—55 dry, 54 wet, 10 a.m.                                                                                 |          |              |       |    |
| 6             | "            | 3,555  | 44.0       |        | 56 " 56 " 3 p.m.                                                                                                      |          |              |       |    |
| 7             | "            | 4,907  | 62.0       |        |                                                                                                                       |          |              |       |    |
| 8             | "            | 4,798  | 60.2       |        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.28</td><td>56</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.28 | 56 |
| Reading.      | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 29.28         | 56           |        |            |        |                                                                                                                       |          |              |       |    |
|               |              |        |            |        | 29.35 56 3 p.m.                                                                                                       |          |              |       |    |
|               |              |        |            |        | October 28, 1864.                                                                                                     |          |              |       |    |
| 1             | 15           | 4,687  | 82.6       |        | The gun was 58 feet to right of line.                                                                                 |          |              |       |    |
| 2             | "            | 4,697  | 77.0       |        | Weather :—Thick haze on water, 10 a.m.                                                                                |          |              |       |    |
| 3             | "            | 4,671  | 79.0       |        | Slight haze, 3 p.m.                                                                                                   |          |              |       |    |
| 4             | "            | 4,648  | 78.6       |        |                                                                                                                       |          |              |       |    |
| 5             | "            | 4,471  | 69.6       |        | Wind :—Direction, N.E. by E. ; force, 1 ; 10 a.m.                                                                     |          |              |       |    |
| 6             | "            | 4,696  | 75.4       |        | " E. by N. ; " 3 ; 3 p.m.                                                                                             |          |              |       |    |
| 7             | "            | 4,660  | 80.6       |        |                                                                                                                       |          |              |       |    |
| 8             | "            | 4,324  | 98.0       |        | Thermometer :—56 dry, 55 wet, 10 a.m.                                                                                 |          |              |       |    |
| 9             | "            | 4,576  | 72.8       |        | 57 " 56 " 3 p.m.                                                                                                      |          |              |       |    |
| 10            | "            | 4,424  | 86.0       |        |                                                                                                                       |          |              |       |    |
| 11            | "            | 4,626  | 76.0       |        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.55</td><td>58</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.55 | 58 |
| Reading.      | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 29.55         | 58           |        |            |        |                                                                                                                       |          |              |       |    |
| 12            | "            | 4,386  | 69.0       |        | 29.55 57 3 p.m.                                                                                                       |          |              |       |    |
|               |              |        |            |        | June 21, 1865.                                                                                                        |          |              |       |    |
| 1             | 15           | 4,750  | 33.0       |        |                                                                                                                       |          |              |       |    |
| 2             | "            | 4,770  | 15.2       |        |                                                                                                                       |          |              |       |    |
| 3             | "            | 4,844  | 8.6        |        |                                                                                                                       |          |              |       |    |
| 4             | "            | 4,824  | 17.6       |        |                                                                                                                       |          |              |       |    |
| 5             | "            | 4,748  | 4.4        |        |                                                                                                                       |          |              |       |    |
| 6             | "            | 4,780  | 13.6       |        |                                                                                                                       |          |              |       |    |
| 7             | "            | 4,746  | 24.0       |        | Weather :—Clear.                                                                                                      |          |              |       |    |
| 8             | "            | 4,700  | 13.0       |        |                                                                                                                       |          |              |       |    |
| 9             | "            | 4,860  | 14.0       |        | Wind :—Direction, S.E. by S. ; force, 2 ; 10 a.m.                                                                     |          |              |       |    |
| 10            | "            | 4,442  | 16.0       |        | " " " 2 ; 3 p.m.                                                                                                      |          |              |       |    |
| 11            | "            | 4,772  | 21.0       |        |                                                                                                                       |          |              |       |    |
| 12            | "            | 4,704  | 26.4       |        | Thermometer :—67 dry, 64 wet, 10 a.m.                                                                                 |          |              |       |    |
| 13            | "            | 4,747  | 15.0       |        | 70 " 66 " 3 p.m.                                                                                                      |          |              |       |    |
| 14            | "            | 4,675  | 18.0       |        |                                                                                                                       |          |              |       |    |
| 15            | "            | 4,726  | 22.0       |        |                                                                                                                       |          |              |       |    |
| 16            | "            | 4,621  | 29.0       |        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.40</td><td>67</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.40 | 67 |
| Reading.      | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 30.40         | 67           |        |            |        |                                                                                                                       |          |              |       |    |
| 17            | "            | 4,724  | 19.0       |        | 30.40 67 3 p.m.                                                                                                       |          |              |       |    |
| 18            | "            | 4,706  | 27.2       |        |                                                                                                                       |          |              |       |    |
| 19            | "            | 4,686  | 49.0       |        |                                                                                                                       |          |              |       |    |
| 20            | "            | 4,662  | 15.0       |        |                                                                                                                       |          |              |       |    |
| 21            | "            | 4,685  | 31.0       |        |                                                                                                                       |          |              |       |    |
| 22            | "            | 4,778  | 34.0       |        |                                                                                                                       |          |              |       |    |
| 23            | "            | 4,646  | 32.0       |        |                                                                                                                       |          |              |       |    |

RANGE AND ACCURACY.—SHOT—*continued.*

| No. of Round. | Elevation.   | Range. | 1st Graze. | Remarks.                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
|---------------|--------------|--------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | Right.     |                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |              |       |    |       |    |
|               | °            | Yards. | Yards.     |                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |              |       |    |       |    |
| 1             | 21           | 5,602  | 79.0       | <i>November 22, 1864.</i><br><br>The gun was 9 feet left of line.<br>Weather :—Hazy and raining, 10 a.m.<br>Clearing up, 3 p.m.<br>Wind :—Direction, W.S.W. ; force, 3 ; 10 a.m.<br>" N.W. by W. " 5 ; 3 p.m.<br>Thermometer :—49 dry, 49 wet, 10 a.m.<br>49 " 47 " 3 p.m.<br>Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.65</td><td>51</td></tr><tr><td>29.55</td><td>52</td></tr></table> 10 a.m.<br> | Reading. | Temperature. | 29.65 | 51 | 29.55 | 52 |
| Reading.      | Temperature. |        |            |                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |              |       |    |       |    |
| 29.65         | 51           |        |            |                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |              |       |    |       |    |
| 29.55         | 52           |        |            |                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |              |       |    |       |    |



RANGE AND ACCURACY.—SHOT—*continued.*

## AFTER FIRING 3,000 ROUNDS.

| No. of Round. | Elevation. | Range. | 1st Graze. |        | Remarks.                                                               |
|---------------|------------|--------|------------|--------|------------------------------------------------------------------------|
|               |            |        | Right.     | Left.  |                                                                        |
|               | °          | Yards. | Yards.     | Yards. |                                                                        |
| 1             | 6          | 2,330  | 9·8        | —      | <i>June 19, 1865.</i>                                                  |
| 2             | "          | 2,317  | 8·0        | —      |                                                                        |
| 3             | "          | 2,291  | 10·0       | —      |                                                                        |
| 4             | "          | 2,374  | 11·4       | —      |                                                                        |
| 5             | "          | 2,333  | 8·0        | —      |                                                                        |
| 6             | "          | 2,323  | 11·0       | —      |                                                                        |
| 7             | "          | 2,366  | 10·6       | —      |                                                                        |
| 8             | "          | 2,320  | 14·4       | —      |                                                                        |
| 9             | "          | 2,360  | 12·0       | —      |                                                                        |
| 10            | "          | 2,248  | 12·0       | —      |                                                                        |
| 11            | "          | 2,319  | 9·0        | —      | Weather:—Clear.                                                        |
| 12            | "          | 2,296  | 11·4       | —      |                                                                        |
| 13            | "          | 2,345  | 9·0        | —      |                                                                        |
| 14            | "          | 2,320  | 8·0        | —      |                                                                        |
| 15            | "          | 2,321  | 9·0        | —      |                                                                        |
| 16            | "          | 2,386  | 8·0        | —      |                                                                        |
| 17            | "          | 2,370  | 6·0        | —      |                                                                        |
| 18            | "          | 2,360  | 6·4        | —      |                                                                        |
| 19            | "          | 2,344  | 6·0        | —      |                                                                        |
| 20            | "          | 2,262  | 6·8        | —      |                                                                        |
| 21            | "          | 2,314  | 4·0        | —      | Wind:—Direction, E.N.E.; force, 2; 10 a.m.<br>" S.E. by E. " 2; 3 p.m. |
| 22            | "          | 2,322  | 3·2        | —      |                                                                        |
| 23            | "          | 2,308  | 3·0        | —      |                                                                        |
| 24            | "          | 2,302  | 4·0        | —      |                                                                        |
| 25            | "          | 2,350  | 2·0        | —      |                                                                        |
| 26            | "          | 2,273  | 2·0        | —      |                                                                        |
| 27            | "          | 2,288  | 3·0        | —      |                                                                        |
| 28            | "          | 2,296  | 2·4        | —      |                                                                        |
| 29            | "          | 2,338  | 1·4        | —      |                                                                        |
| 30            | "          | 2,318  | 1·6        | —      |                                                                        |
| 31            | "          | 2,246  | 4·0        | —      | Thermometer:—56 dry, 54 wet, 10 a.m.<br>61 " 59 " 3 p.m.               |
| 32            | "          | 2,335  | 1·4        | —      |                                                                        |
| 33            | "          | 2,325  | 6·0        | —      |                                                                        |

Barometer:—

|          |              |
|----------|--------------|
| Reading. | Temperature. |
| 29·90    | 58 10 a.m.   |
| 30·35    | 60 3 p.m.    |

COMMON SHELL (WEIGHTED WITH SAND).

PARTICULARS OF SHELL AND AMMUNITION.

N.B.—The figures in *Italics* are the rounds struck out by the competitors as abnormal shots.

SHOEBURYNESS.

*Projectile.*

Nature, common shell.  
Weight, 68½ lbs.  
Diameter, 6·43 inches.

Length, 14·66 inches.  
Bursting charge, 4·8 lbs.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | Right.     | Left.  |                                                                                                                                                         |          |              |       |    |       |    |
|               | °            | Yards. | Yards.     | Yards. | November 8, 1864.                                                                                                                                       |          |              |       |    |       |    |
| 1             | 1            | 705    | —          | 5·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "            | 743    | —          | 4·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 750    | —          | 4·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "            | 754    | —          | 4·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "            | 747    | —          | 5·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 6             | "            | 721    | —          | 4·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 7             | "            | 696    | —          | 4·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 8             | "            | 714    | —          | 4·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 9             | "            | 744    | —          | 5·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 10            | "            | 735    | —          | 5·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 11            | "            | 720    | —          | 5·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "            | 729    | —          | 5·0    | The gun was 9 feet left of line.                                                                                                                        |          |              |       |    |       |    |
| 13            | "            | 690    | —          | 4·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 14            | "            | 730    | —          | 4·8    | Weather :—Thick haze, 10 a.m.                                                                                                                           |          |              |       |    |       |    |
| 15            | "            | 699    | —          | 4·6    | Foggy, 3 p.m.                                                                                                                                           |          |              |       |    |       |    |
| 16            | "            | 725    | —          | 4·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 17            | "            | 701    | —          | 4·6    | Wind :—Direction, N.N.W. ; force, 3 ; 10 a.m.                                                                                                           |          |              |       |    |       |    |
| 18            | "            | 690    | —          | 4·8    | " N. " 1 ; 3 p.m.                                                                                                                                       |          |              |       |    |       |    |
| 19            | "            | 713    | —          | 4·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 20            | "            | 736    | —          | 4·6    | Thermometer :—39 dry, 38 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 21            | "            | 707    | —          | 5·0    | 45 " 44 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 22            | "            | 697    | —          | 5·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 23            | "            | 703    | —          | 4·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 24            | "            | 678    | —          | 4·2    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·10</td><td>43</td></tr><tr><td>30·08</td><td>46</td></tr></table> 10 a.m. | Reading. | Temperature. | 30·10 | 43 | 30·08 | 46 |
| Reading.      | Temperature. |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·10         | 43           |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·08         | 46           |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 25            | "            | 692    | —          | 4·2    | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 26            | "            | 694    | —          | 2·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 27            | "            | 694    | —          | 4·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 28            | "            | 690    | —          | 3·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 29            | "            | 701    | —          | 4·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 30            | "            | 696    | —          | 3·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 31            | "            | 711    | —          | 3·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 32            | "            | 695    | —          | 4·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 33            | "            | 719    | —          | 4·8    |                                                                                                                                                         |          |              |       |    |       |    |

RANGE AND ACCURACY.—COMMON SHELL—*continued.*

| No. of Round.      | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                              |          |              |       |    |
|--------------------|--------------|--------|------------|--------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|                    |              |        | Right.     | Left.  |                                                                                                                       |          |              |       |    |
|                    | °            | Yards. | Yards.     | Yards. | November 22, 1864.                                                                                                    |          |              |       |    |
| 1                  | 4            | 1,564  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 2                  | "            | 1,544  | 15.0       | —      |                                                                                                                       |          |              |       |    |
| 3                  | "            | 1,570  | 16.0       | —      |                                                                                                                       |          |              |       |    |
| 4                  | "            | 1,590  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 5                  | "            | 1,590  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 6                  | "            | 1,576  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 7                  | "            | 1,540  | 16.0       | —      |                                                                                                                       |          |              |       |    |
| 8                  | "            | 1,568  | 12.0       | —      |                                                                                                                       |          |              |       |    |
| 9                  | "            | 1,496  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 10                 | "            | 1,496  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 11                 | "            | 1,510  | 13.0       | —      | The gun was 39 feet right of line.                                                                                    |          |              |       |    |
| 12                 | "            | 1,596  | 12.4       | —      |                                                                                                                       |          |              |       |    |
| 13                 | "            | 1,584  | 13.0       | —      | Weather :—Hazy and raining, 10 a.m.                                                                                   |          |              |       |    |
| 14                 | "            | 1,560  | 12.0       | —      | Clearing up, 3 p.m.                                                                                                   |          |              |       |    |
| 15                 | "            | 1,540  | 15.0       | —      |                                                                                                                       |          |              |       |    |
| 16                 | "            | 1,538  | 14.4       | —      | Wind :—Direction, W.S.W.; force, 3; 10 a.m.                                                                           |          |              |       |    |
| 17                 | "            | 1,564  | 16.0       | —      | " N.W. by W. " 5; 3 p.m.                                                                                              |          |              |       |    |
| 18                 | "            | 1,588  | 11.2       | —      |                                                                                                                       |          |              |       |    |
| 19                 | "            | 1,562  | 12.0       | —      | Thermometer :—49 dry, 49 wet, 10 a.m.                                                                                 |          |              |       |    |
| 20                 | "            | 1,552  | 14.0       | —      | 49 " 47 " 3 p.m.                                                                                                      |          |              |       |    |
| 21                 | "            | 1,536  | 12.0       | —      |                                                                                                                       |          |              |       |    |
| 22                 | "            | 1,546  | 12.2       | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.65</td><td>51</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.65 | 51 |
| Reading.           | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 29.65              | 51           |        |            |        |                                                                                                                       |          |              |       |    |
| 23                 | "            | 1,504  | 11.2       | —      | <table><tr><td>29.55</td><td>52</td></tr></table> 3 p.m.                                                              | 29.55    | 52           |       |    |
| 29.55              | 52           |        |            |        |                                                                                                                       |          |              |       |    |
| 24                 | "            | 1,556  | 12.0       | —      |                                                                                                                       |          |              |       |    |
| 25                 | "            | 1,500  | 11.4       | —      |                                                                                                                       |          |              |       |    |
| 26                 | "            | 1,514  | 13.0       | —      |                                                                                                                       |          |              |       |    |
| 27                 | "            | 1,530  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 28                 | "            | 1,545  | 16.0       | —      |                                                                                                                       |          |              |       |    |
| 29                 | "            | 1,450  | 15.4       | —      |                                                                                                                       |          |              |       |    |
| 30                 | "            | 1,562  | 11.4       | —      |                                                                                                                       |          |              |       |    |
| 31                 | "            | 1,517  | 10.4       | —      |                                                                                                                       |          |              |       |    |
| 32                 | "            | 1,540  | 17.0       | —      |                                                                                                                       |          |              |       |    |
| 33                 | "            | 1,506  | 10.0       | —      |                                                                                                                       |          |              |       |    |
| November 21, 1864. |              |        |            |        |                                                                                                                       |          |              |       |    |
| 1                  | 7            | 2,513  | 19.4       | —      |                                                                                                                       |          |              |       |    |
| 2                  | "            | 2,566  | 22.2       | —      |                                                                                                                       |          |              |       |    |
| 3                  | "            | 2,600  | 23.6       | —      |                                                                                                                       |          |              |       |    |
| 4                  | "            | 2,769  | 23.8       | —      |                                                                                                                       |          |              |       |    |
| 5                  | "            | 2,578  | 23.6       | —      |                                                                                                                       |          |              |       |    |
| 6                  | "            | 2,630  | 22.0       | —      |                                                                                                                       |          |              |       |    |
| 7                  | "            | 2,654  | 22.6       | —      |                                                                                                                       |          |              |       |    |
| 8                  | "            | 2,704  | 22.8       | —      |                                                                                                                       |          |              |       |    |
| 9                  | "            | 2,625  | 22.6       | —      |                                                                                                                       |          |              |       |    |
| 10                 | "            | 2,612  | 22.6       | —      |                                                                                                                       |          |              |       |    |
| 11                 | "            | 2,615  | 22.6       | —      |                                                                                                                       |          |              |       |    |
| 12                 | "            | 2,590  | 22.4       | —      |                                                                                                                       |          |              |       |    |
| 13                 | "            | 2,531  | 20.8       | —      |                                                                                                                       |          |              |       |    |
| 14                 | "            | 2,590  | 20.0       | —      | The gun was 39 feet right of line.                                                                                    |          |              |       |    |
| 15                 | "            | 2,592  | 23.0       | —      |                                                                                                                       |          |              |       |    |
| 16                 | "            | 2,670  | 21.0       | —      | Weather :—Hazy.                                                                                                       |          |              |       |    |
| 17                 | "            | 2,494  | 18.0       | —      |                                                                                                                       |          |              |       |    |
| 18                 | "            | 2,474  | 18.8       | —      | Wind :—Direction, N.W. by W.; force, 2; 10 a.m.                                                                       |          |              |       |    |
| 19                 | "            | 2,564  | 20.0       | —      | " S.W. by W. " 3; 3 p.m.                                                                                              |          |              |       |    |
| 20                 | "            | 2,584  | 20.4       | —      |                                                                                                                       |          |              |       |    |
| 21                 | "            | 2,579  | 17.8       | —      | Thermometer :—45 dry, 44 wet, 10 a.m.                                                                                 |          |              |       |    |
| 22                 | "            | 2,472  | 18.6       | —      | 49 " 48 " 3 p.m.                                                                                                      |          |              |       |    |
| 23                 | "            | 2,475  | 20.0       | —      |                                                                                                                       |          |              |       |    |
| 24                 | "            | 2,372  | 16.8       | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.88</td><td>49</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.88 | 49 |
| Reading.           | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 29.88              | 49           |        |            |        |                                                                                                                       |          |              |       |    |
| 25                 | "            | 2,550  | 19.6       | —      | <table><tr><td>29.90</td><td>51</td></tr></table> 3 p.m.                                                              | 29.90    | 51           |       |    |
| 29.90              | 51           |        |            |        |                                                                                                                       |          |              |       |    |
| 26                 | "            | 2,494  | 20.4       | —      |                                                                                                                       |          |              |       |    |
| 27                 | "            | 2,545  | 19.6       | —      |                                                                                                                       |          |              |       |    |
| 28                 | "            | 2,509  | 19.4       | —      |                                                                                                                       |          |              |       |    |
| 29                 | "            | 2,375  | 19.8       | —      |                                                                                                                       |          |              |       |    |
| 30                 | "            | 2,570  | 24.8       | —      |                                                                                                                       |          |              |       |    |
| 31                 | "            | 2,600  | 23.0       | —      |                                                                                                                       |          |              |       |    |
| 32                 | "            | 2,593  | 20.6       | —      |                                                                                                                       |          |              |       |    |
| 33                 | "            | 2,616  | 23.8       | —      |                                                                                                                       |          |              |       |    |
| 34                 | "            | 2,623  | 23.6       | —      |                                                                                                                       |          |              |       |    |
| 35                 | "            | 2,636  | 23.2       | —      |                                                                                                                       |          |              |       |    |
| 36                 | "            | 2,607  | 21.6       | —      |                                                                                                                       |          |              |       |    |
| 37                 | "            | 2,636  | 22.6       | —      |                                                                                                                       |          |              |       |    |
| 38                 | "            | 2,585  | 27.8       | —      |                                                                                                                       |          |              |       |    |

RANGE AND ACCURACY.—COMMON SHELL—*continued.*

| No. of Round. | Elevation. | Range. | 1st Graze. |        | Remarks.                                                                  |
|---------------|------------|--------|------------|--------|---------------------------------------------------------------------------|
|               |            |        | Right.     | Left.  |                                                                           |
|               | °          | Yards. | Yards.     | Yards. | <i>November 10, 1864.</i>                                                 |
| 1             | 10         | 3,212  | 32.0       | —      |                                                                           |
| 2             | "          | 3,396  | 31.6       | —      |                                                                           |
| 3             | "          | 3,424  | 33.0       | —      |                                                                           |
| 4             | "          | 3,432  | 29.0       | —      |                                                                           |
| 5             | "          | 3,403  | 32.6       | —      |                                                                           |
| 6             | "          | 3,332  | 36.6       | —      |                                                                           |
| 7             | "          | 3,344  | 29.0       | —      | To correspond with Whitworth, broke up.                                   |
| 8             | "          | 3,398  | 30.0       | —      | The gun was in line.                                                      |
| 9             | "          | 3,380  | 33.6       | —      |                                                                           |
| 10            | "          | 3,397  | 32.0       | —      | Weather :—Clear.                                                          |
| 11            | "          | 3,388  | 29.0       | —      |                                                                           |
| 12            | "          | 3,356  | 30.6       | —      | Wind :—Direction, E.S.E. ; force, 5 ; 10 a.m.                             |
| 13            | "          | 3,360  | 29.0       | —      | " E. by S. " 3 ; 3 p.m.                                                   |
| 14            | "          | 3,412  | 30.0       | —      |                                                                           |
| 15            | "          | 3,396  | 29.4       | —      | Thermometer :—43 dry, 41 wet, 10 a.m.                                     |
| 16            | "          | 3,348  | 26.0       | —      | 43 " 41 " 3 p.m.                                                          |
| 17            | "          | 3,358  | 31.0       | —      |                                                                           |
| 18            | "          | 3,244  | 26.0       | —      |                                                                           |
| 19            | "          | 3,285  | 29.0       | —      | Barometer :— <sup>Reading.</sup> 30.10 <sup>Temperature.</sup> 47 10 a.m. |
| 20            | "          | 3,358  | 31.0       | —      | 30.05 46 3 p.m.                                                           |
| 21            | "          | 3,294  | 28.6       | —      |                                                                           |
| 22            | "          | 3,362  | 33.6       | —      | Gun sponged out, and the sponge was used every                            |
| 23            | "          | 3,314  | 29.6       | —      | four rounds after.                                                        |
| 24            | "          | 3,290  | 28.0       | —      |                                                                           |
| 25            | "          | 3,348  | 24.0       | —      |                                                                           |
| 26            | "          | 3,337  | 30.6       | —      |                                                                           |
| 27            | "          | 3,184  | 32.6       | —      |                                                                           |
| 28            | "          | 3,148  | 26.0       | —      |                                                                           |
| 29            | "          | 3,250  | 28.0       | —      |                                                                           |
| 30            | "          | 3,284  | 30.6       | —      |                                                                           |
| 31            | "          | 3,342  | 32.0       | —      |                                                                           |
| 32            | "          | 3,295  | 24.6       | —      |                                                                           |
|               |            |        |            |        | <i>November 21, 1864.</i>                                                 |
| 1             | 17         | 4,984  | 31.0       | —      |                                                                           |
| 2             | "          | 5,040  | 42.0       | —      |                                                                           |
| 3             | "          | 5,104  | 43.0       | —      | The gun was 9 feet left of line.                                          |
| 4             | "          | 5,114  | 52.0       | —      |                                                                           |
| 5             | "          | 5,048  | 40.0       | —      | Weather :—Hazy, 10 a.m.                                                   |
| 6             | "          | 5,112  | 51.0       | —      | " 3 p.m.                                                                  |
| 7             | "          | 5,055  | 45.0       | —      |                                                                           |
| 8             | "          | 5,080  | 41.0       | —      | Wind :—Direction, N.W. by W. ; force, 2 ; 10 a.m.                         |
| 9             | "          | 5,020  | 40.0       | —      | " S.W. by W. " 3 ; 3 p.m.                                                 |
| 10            | "          | 5,022  | 45.0       | —      |                                                                           |
| 11            | "          | 5,054  | 51.0       | —      | Thermometer :—45 dry, 44 wet, 10 a.m.                                     |
| 12            | "          | 5,075  | 52.0       | —      | 49 " 48 " 3 p.m.                                                          |
| 13            | "          | 5,024  | 54.0       | —      |                                                                           |
| 14            | "          | 4,074  | 45.0       | —      |                                                                           |
| 15            | "          | 5,080  | 55.0       | —      | Barometer :— <sup>Reading.</sup> 29.88 <sup>Temperature.</sup> 49 10 a.m. |
| 16            | "          | 5,002  | 31.0       | —      | 29.90 51 3 p.m.                                                           |
| 17            | "          | 4,890  | 31.0       | —      |                                                                           |
| 18            | "          | 4,868  | 40.0       | —      |                                                                           |
| 19            | "          | 5,000  | 41.0       | —      |                                                                           |
| 20            | "          | 5,042  | 42.0       | —      |                                                                           |

RANGE AND ACCURACY—*continued.*

## SEGMENT SHELL (WEIGHTED WITH SAND.)

## PARTICULARS OF SHELL AND AMMUNITION.

Nature, segment shell.  
Weight, 77·6 lbs.  
Diameter, 6·43 inches.

Length, 13·85 inches.  
No. of segments, 112.  
Bursting charge, 1 lb.

| No of Rounds. | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | In Line.   | Right. | Left.  |                                                                                                                                                         |          |              |       |    |       |    |
|               | °            | Yards. |            | Yards. | Yards. |                                                                                                                                                         |          |              |       |    |       |    |
| 1             | 2            | 978    | —          | 18·2   | —      | October 11, 1864.                                                                                                                                       |          |              |       |    |       |    |
| 2             | "            | 1,041  | —          | 19·4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 1,028  | —          | 19·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "            | 1,055  | —          | 21·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "            | 1,016  | —          | 18·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 6             | "            | 1,024  | —          | 19·6   | —      | The gun was 58 feet right of line.                                                                                                                      |          |              |       |    |       |    |
| 7             | "            | 1,016  | —          | 19·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 8             | "            | 1,011  | —          | 19·8   | —      | Weather :— Thick haze.                                                                                                                                  |          |              |       |    |       |    |
| 9             | "            | 1,016  | —          | 18·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 10            | "            | 1,041  | —          | 15·6   | —      | Wind :—Direction, N. ; force, 2 ; 10 a.m.                                                                                                               |          |              |       |    |       |    |
| 11            | "            | 1,016  | —          | 18·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "            | 1,033  | —          | 19·4   | —      | " " " 2 ; 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 13            | "            | 1,008  | —          | 17·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 14            | "            | 1,047  | —          | 19·2   | —      | Thermometer :—52 dry, 50 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 15            | "            | 1,027  | —          | 19·4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 16            | "            | 1,013  | —          | 19·2   | —      | 55 " 52 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 17            | "            | 1,035  | —          | 18·4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 18            | "            | 1,031  | —          | 19·0   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·42</td><td>54</td></tr><tr><td>30·45</td><td>68</td></tr></table> 10 a.m. | Reading. | Temperature. | 30·42 | 54 | 30·45 | 68 |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·42         | 54           |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·45         | 68           |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 19            | "            | 1,023  | —          | 18·8   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 20            | "            | 985    | —          | 18·4   | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 21            | "            | 1,050  | —          | 19·2   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 22            | "            | 1,021  | —          | 18·4   | —      | Corresponding round, Whitworth, broke up.                                                                                                               |          |              |       |    |       |    |
| 23            | "            | 1,016  | —          | 18·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 24            | "            | 955    | —          | 18·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 25            | "            | 978    | —          | 19·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 26            | "            | 997    | —          | 20·4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 27            | "            | 984    | —          | 19·6   | —      | Corresponding round, Whitworth, broke up.                                                                                                               |          |              |       |    |       |    |
| 28            | "            | 990    | —          | 19·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 29            | "            | 990    | —          | 19·2   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 30            | "            | 1,011  | —          | 19·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 31            | "            | 1,010  | —          | 18·4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 32            | "            | 984    | —          | 19·8   | —      | Corresponding round, Whitworth, broke up.                                                                                                               |          |              |       |    |       |    |
| 33            | "            | 1,018  | —          | 19·8   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 34            | "            | 984    | —          | 19·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 35            | "            | 1,013  | —          | 18·0   | —      | Corresponding round, Whitworth, not fired.                                                                                                              |          |              |       |    |       |    |
| 36            | "            | 978    | —          | 20·8   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 37            | "            | 968    | —          | 19·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |



RANGE AND ACCURACY.—SEGMENT SHELL—*continued.*

| No. of Rounds.    | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                              |          |              |       |    |
|-------------------|--------------|--------|------------|--------|--------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|                   |              |        | In Line.   | Right. | Left.  |                                                                                                                       |          |              |       |    |
| November 9, 1864. |              |        |            |        |        |                                                                                                                       |          |              |       |    |
|                   | °            | Yards. |            | Yards. | Yards. |                                                                                                                       |          |              |       |    |
| 1                 | 5            | 1,935  | —          | 0.6    | —      | The gun was 9 feet left of line.                                                                                      |          |              |       |    |
| 2                 | "            | 2,006  | —          | —      | 3.0    | Weather :—Clear.                                                                                                      |          |              |       |    |
| 3                 | "            | 1,978  | —          | —      | 1.4    | Wind :—Direction, N.E. by E. ; force, 3 ; 10 a.m.                                                                     |          |              |       |    |
| 4                 | "            | 1,960  | —          | —      | 3.6    | " E. by N. ; " 4 ; 3 p.m.                                                                                             |          |              |       |    |
| 5                 | "            | 1,922  | —          | 2.0    | —      | Thermometer :—42 dry, 41 wet, 10 a.m.                                                                                 |          |              |       |    |
| 6                 | "            | 1,925  | —          | 2.8    | —      | 46 " 43 " 3 p.m.                                                                                                      |          |              |       |    |
| 7                 | "            | 1,912  | Yes.       | —      | —      |                                                                                                                       |          |              |       |    |
| 3                 | "            | 1,948  | —          | 1.6    | —      |                                                                                                                       |          |              |       |    |
| 9                 | "            | 1,947  | —          | —      | 3.4    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.15</td><td>44</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.15 | 44 |
| Reading.          | Temperature. |        |            |        |        |                                                                                                                       |          |              |       |    |
| 30.15             | 44           |        |            |        |        |                                                                                                                       |          |              |       |    |
| 10                | "            | 1,961  | —          | —      | 3.0    | 30.12 46 3 p.m.                                                                                                       |          |              |       |    |
| 11                | "            | 1,913  | —          | —      | 2.0    |                                                                                                                       |          |              |       |    |
| 12                | "            | 1,939  | —          | —      | 2.0    | Corresponding round, Whitworth, broke up.                                                                             |          |              |       |    |
| 13                | "            | 1,932  | —          | —      | 0.2    | Ditto ditto.                                                                                                          |          |              |       |    |
| 14                | "            | 1,958  | —          | 0.4    | —      | Ditto ditto.                                                                                                          |          |              |       |    |
| 15                | "            | 1,926  | Yes.       | —      | —      |                                                                                                                       |          |              |       |    |
| 16                | "            | 1,908  | —          | —      | 1.6    |                                                                                                                       |          |              |       |    |
| 17                | "            | 1,907  | —          | —      | 4.0    |                                                                                                                       |          |              |       |    |
| 18                | "            | 1,882  | —          | —      | 3.0    |                                                                                                                       |          |              |       |    |
| 19                | "            | 1,910  | —          | —      | 1.6    |                                                                                                                       |          |              |       |    |
| 20                | "            | 1,867  | —          | 0.4    | —      | Ditto ditto.                                                                                                          |          |              |       |    |
| 21                | "            | 1,876  | —          | —      | 0.4    | Ditto ditto.                                                                                                          |          |              |       |    |
| 22                | "            | 1,874  | —          | 2.0    | —      |                                                                                                                       |          |              |       |    |
| 23                | "            | 1,698  | —          | 7.6    | —      | Ditto ditto.                                                                                                          |          |              |       |    |
| 24                | "            | 1,911  | —          | 2.0    | —      |                                                                                                                       |          |              |       |    |
| 25                | "            | 1,887  | —          | —      | 1.0    | Ditto ditto.                                                                                                          |          |              |       |    |
| October 13, 1864. |              |        |            |        |        |                                                                                                                       |          |              |       |    |
| 1                 | 8            | 2,754  | —          | 36.0   | —      |                                                                                                                       |          |              |       |    |
| 2                 | "            | 2,942  | —          | 36.6   | —      | The gun was 58 feet right of line.                                                                                    |          |              |       |    |
| 3                 | "            | 2,860  | —          | 34.8   | —      | Weather :—Clear, 10 a.m.                                                                                              |          |              |       |    |
| 4                 | "            | 2,824  | —          | 36.2   | —      | Thick haze, 3 p.m.                                                                                                    |          |              |       |    |
| 5                 | "            | 2,788  | —          | 39.4   | —      |                                                                                                                       |          |              |       |    |
| 6                 | "            | 2,858  | —          | 35.0   | —      |                                                                                                                       |          |              |       |    |
| *7                | "            | 2,788  | —          | 38.8   | —      | Wind :—Direction, N. by W. ; force, 3 ; 10 a.m.                                                                       |          |              |       |    |
| 8                 | "            | 2,822  | —          | 37.2   | —      | " N.N.W ; " 2 ; 3 p.m.                                                                                                |          |              |       |    |
| 9                 | "            | 2,796  | —          | 32.8   | —      |                                                                                                                       |          |              |       |    |
| 10                | "            | 2,703  | —          | 37.6   | —      | Thermometer :—53 dry, 51 wet, 10 a.m.                                                                                 |          |              |       |    |
| 11                | "            | 2,837  | —          | 35.4   | —      | 59 " 55 " 3 p.m.                                                                                                      |          |              |       |    |
| *12               | "            | 2,840  | —          | 35.4   | —      |                                                                                                                       |          |              |       |    |
| 13                | "            | 2,790  | —          | 34.2   | —      |                                                                                                                       |          |              |       |    |
| 14                | "            | 2,768  | —          | 37.2   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.10</td><td>60</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.10 | 60 |
| Reading.          | Temperature. |        |            |        |        |                                                                                                                       |          |              |       |    |
| 30.10             | 60           |        |            |        |        |                                                                                                                       |          |              |       |    |
| *15               | "            | 2,833  | —          | 35.6   | —      | 30.10 60 3 p.m.                                                                                                       |          |              |       |    |
| 16                | "            | 2,810  | —          | 38.6   | —      |                                                                                                                       |          |              |       |    |
| 17                | "            | 2,775  | —          | 38.6   | —      |                                                                                                                       |          |              |       |    |
| 18                | "            | 2,832  | —          | 32.2   | —      | *Corresponding rounds, Whitworth, broke up.                                                                           |          |              |       |    |
| 19                | "            | 2,838  | —          | 32.0   | —      |                                                                                                                       |          |              |       |    |
| 20                | "            | 2,759  | —          | 30.6   | —      |                                                                                                                       |          |              |       |    |
| 21                | "            | 2,387  | —          | 30.0   | —      |                                                                                                                       |          |              |       |    |
| 22                | "            | 2,747  | —          | 30.4   | —      |                                                                                                                       |          |              |       |    |
| 23                | "            | 2,661  | —          | 32.2   | —      |                                                                                                                       |          |              |       |    |
| 24                | "            | 2,846  | —          | 33.4   | —      |                                                                                                                       |          |              |       |    |
| 25                | "            | 2,815  | —          | 30.0   | —      |                                                                                                                       |          |              |       |    |

SEA SERVICE TRIALS—*continued.*En ricochet.—*November 14 and 15, 1864.*

| Rounds. | Struck<br>Water<br>short of<br>the<br>Ship. | Armstrong B.L.                                                   |                                                                                                                     |   |
|---------|---------------------------------------------|------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|---|
|         | Yards.                                      |                                                                  |                                                                                                                     |   |
| 1       | 60                                          | Burst (in-board).                                                |                                                                                                                     |   |
| 2       | 6                                           | Burst (in outer planking, probably immediately after 1st graze). |                                                                                                                     |   |
| 3       | 20                                          | Burst                                                            | In-board. { One of these shells burst in shelf piece below lower deck, fracturing 2 beams and several planks above. |   |
| 4       | 15                                          | Burst                                                            |                                                                                                                     |   |
| 5       | 10                                          | Burst                                                            |                                                                                                                     |   |
| 6       | 25                                          | Burst                                                            |                                                                                                                     |   |
| 7       | 100                                         | Ricocheted over ship.                                            |                                                                                                                     |   |
| 8       | 30                                          | Burst                                                            | In-board.                                                                                                           |   |
| 9       | 90                                          | Burst                                                            |                                                                                                                     |   |
| 10      | 5                                           | Burst                                                            |                                                                                                                     |   |
| 11      | 45                                          | Burst                                                            |                                                                                                                     |   |
| 12      | 50                                          | Burst                                                            |                                                                                                                     |   |
| 13      | 60                                          | Burst                                                            |                                                                                                                     |   |
| 14      | —                                           | —                                                                | —                                                                                                                   | — |
| 15      | —                                           | —                                                                | —                                                                                                                   | — |
| 16      | —                                           | —                                                                | —                                                                                                                   | — |



SEA SERVICE TRIALS—continued.

PRACTICE with COMMON SHELL and PERCUSSION FUZES, from the 70-pounder B.L. ARMSTRONG GUN, mounted (on Naval Slide Carriage) on board the Gunboat "STORK," in PORTSMOUTH HARBOUR. Target, "ALFRED," wooden Frigate, distant 700 yards.

|                      |             |         |
|----------------------|-------------|---------|
| Thickness of side at | Upper works | Ft. in. |
|                      | Main deck   | - 1 5   |
|                      | Bends       | - 2 0   |
|                      |             | - 2 5   |

Oak timbers and planking. The main-deck ports were filled in with fir to the thickness of ship's side.  
Hit Direct.—November 4, 1864.

Pillar Percussion Fuze (present Service Gauge).

|                       |               |
|-----------------------|---------------|
| Elevation 1°40'.      |               |
| Shell                 | 64 lbs.       |
| Burster               | 4 3/4 "       |
|                       | 68 3/4 "      |
| Length, 14·63 inches. |               |
| Thickness             | 1·25 (sides). |
|                       | 1·88 (base).  |

12 rounds were fired with the following results :—

- 1 Burst (within 6 feet from side).
- 2 Burst
- 3 Burst
- 4 Burst
- 5 Burst
- 6 Burst
- 7 Burst.
- 8 Burst (on striking chain slings).
- 9 Burst.
- 10 Burst.
- 11 Burst, or broke (pieces beyond vessel).
- 12 No burst, passed through.  
Spread of explosion about 45°; not much damage or splintering.

November 14 and 15.

- 13 Burst.
- 14 Burst.
- 15 Burst.
- 16 Burst.
- 17 Burst (the near side).
- 18 Burst.
- 19 Burst (the opposite side).
- 20 Burst do.
- 21 Burst (the near side).
- 22 Burst.
- 23 Burst.
- 24 Burst.
- 25 Burst.
- 26 Burst (intended for ricochet).
- 27 Burst do.
- 28 — — —
- 29 — — —
- 30 — — —

## RAPID FIRING.

SHOEBURYNESS.

*July 7, 1864.*

The gun was mounted on a rear chock carriage on an ordinary ground platform and worked by men of the Royal Artillery.

The detachments were changed every 20 rounds.

*Shot.*

|                                 |   |   |                           |
|---------------------------------|---|---|---------------------------|
| The 1st 20 rounds were fired in |   |   | 12 $\frac{1}{2}$ minutes. |
| 2nd                             | " | " | - 13 $\frac{1}{2}$ "      |
| 3rd                             | " | " | - 13 $\frac{1}{2}$ "      |
| 4th                             | " | " | - 19 "                    |

This gun detachment never saw a wedge gun before, and only one man of the detachment had been drilled with Armstrong guns.

|                                 |   |   |                           |
|---------------------------------|---|---|---------------------------|
| The 5th 20 rounds were fired in |   |   | 12 $\frac{1}{2}$ minutes. |
| 6th                             | " | " | - 17 "                    |

During the last 20 rounds the wedge worked stiffly.

At the conclusion of the experiment a small quantity of water was thrown into the slot, and the wedge then worked as freely as at the commencement of the practice.



70-POUNDER WHITWORTH GUN. (FIRED FROM REAR-VENT.)

EXPERIMENTS FOR DETERMINING RANGE AND ACCURACY.

N.B.—The figures in *Italics* are the rounds struck out by the competitors as abnormal shots.

SOLID SHOT. SHOEBURYNES.

| Ordnance.                                                     |  | Projectile and Ammunition.                |  |
|---------------------------------------------------------------|--|-------------------------------------------|--|
| Weight, 77 cwt.                                               |  | Weight, 70 lbs.                           |  |
| Length, 9 ft. 11 in.                                          |  | Diameter { major, 5.46 in.                |  |
| Diameter { circumscribed, 5.53 in.                            |  | { minor, 4.98 in.                         |  |
| of circle { inscribed, 5.03 in.                               |  | Length, 15 in.                            |  |
| Length of bore, 9 ft. 0.5 in.                                 |  | Length of cartridge, 14.5 in.             |  |
| Spiral, 1 turn in { 18.08 calibres.                           |  | Diameter of cartridge, 4.9 in.            |  |
| { 20.2       "                                                |  | Brand of powder, A4.                      |  |
|                                                               |  | Charge, 10 lbs.                           |  |
|                                                               |  | Wad, Boxer's lubricator, filled with oil. |  |
| The cartridge was ignited in the centre through a paper tube. |  |                                           |  |

| No. of Round.     | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                              |          |              |       |    |
|-------------------|--------------|--------|------------|--------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|                   |              |        |            | Right. |                                                                                                                       |          |              |       |    |
| October 14, 1864. |              |        |            |        |                                                                                                                       |          |              |       |    |
|                   | °            | Yards. | Yards.     |        |                                                                                                                       |          |              |       |    |
| 1                 | 0            | 496    | 8.0        |        |                                                                                                                       |          |              |       |    |
| 2                 | "            | 424    | 7.0        |        |                                                                                                                       |          |              |       |    |
| 3                 | "            | 476    | 7.2        |        |                                                                                                                       |          |              |       |    |
| 4                 | "            | 512    | 7.4        |        |                                                                                                                       |          |              |       |    |
| 5                 | "            | 484    | 7.0        |        |                                                                                                                       |          |              |       |    |
| 6                 | "            | 483    | 7.2        |        | The gun was 20 feet right of line.                                                                                    |          |              |       |    |
| 7                 | "            | 485    | 6.0        |        |                                                                                                                       |          |              |       |    |
| 8                 | "            | 534    | 7.2        |        | Weather :—Very thick haze.                                                                                            |          |              |       |    |
| 9                 | "            | 490    | 6.2        |        |                                                                                                                       |          |              |       |    |
| 10                | "            | 485    | 7.2        |        | Wind :—Direction, N.W. ; force, 2 ; 10 a.m.                                                                           |          |              |       |    |
| 11                | "            | 489    | 7.0        |        | " " " 2 ; 3 p.m.                                                                                                      |          |              |       |    |
| 12                | "            | 510    | 7.4        |        |                                                                                                                       |          |              |       |    |
| 13                | "            | 540    | 6.4        |        | Thermometer :—53 dry, 52 wet, 10 a.m.                                                                                 |          |              |       |    |
| 14                | "            | 519    | 7.4        |        | 57 " 55 " 3 p.m.                                                                                                      |          |              |       |    |
| 15                | "            | 499    | 7.0        |        |                                                                                                                       |          |              |       |    |
| 16                | "            | 492    | 6.2        |        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.05</td><td>56</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.05 | 56 |
| Reading.          | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 30.05             | 56           |        |            |        |                                                                                                                       |          |              |       |    |
| 17                | "            | 508    | 6.0        |        | <table><tr><td>30.10</td><td>56</td></tr></table> 3 p.m.                                                              | 30.10    | 56           |       |    |
| 30.10             | 56           |        |            |        |                                                                                                                       |          |              |       |    |
| 18                | "            | 523    | 6.4        |        |                                                                                                                       |          |              |       |    |
| 19                | "            | 519    | 7.4        |        |                                                                                                                       |          |              |       |    |
| 20                | "            | 516    | 7.2        |        |                                                                                                                       |          |              |       |    |
| 21                | "            | 520    | 7.0        |        |                                                                                                                       |          |              |       |    |
| 22                | "            | 537    | 6.0        |        |                                                                                                                       |          |              |       |    |
| October 12, 1864. |              |        |            |        |                                                                                                                       |          |              |       |    |
| 1                 | 3            | 1,790  | 13.0       |        |                                                                                                                       |          |              |       |    |
| 2                 | "            | 1,760  | 12.8       |        |                                                                                                                       |          |              |       |    |
| 3                 | "            | 1,321  | 8.0        |        |                                                                                                                       |          |              |       |    |
| 4                 | "            | 1,759  | 15.6       |        |                                                                                                                       |          |              |       |    |
| 5                 | "            | 1,694  | 11.4       |        |                                                                                                                       |          |              |       |    |
| 6                 | "            | 1,780  | 11.2       |        |                                                                                                                       |          |              |       |    |
| 7                 | "            | 1,792  | 14.8       |        |                                                                                                                       |          |              |       |    |
| 8                 | "            | 1,844  | 14.4       |        | The gun was 20 feet right of line.                                                                                    |          |              |       |    |
| 9                 | "            | 1,795  | 14.6       |        |                                                                                                                       |          |              |       |    |
| 10                | "            | 1,765  | 13.0       |        | Weather :—Hazy.                                                                                                       |          |              |       |    |
| 11                | "            | 1,810  | 13.4       |        |                                                                                                                       |          |              |       |    |
| 12                | "            | 1,744  | 11.8       |        | Wind :—Direction, N.N.W. ; force, 3 ; 10 a.m.                                                                         |          |              |       |    |
| 13                | "            | 1,732  | 13.0       |        | " N.W. by N. " 3 ; 3 p.m.                                                                                             |          |              |       |    |
| 14                | "            | 1,774  | 12.2       |        |                                                                                                                       |          |              |       |    |
| 15                | "            | 1,818  | 13.4       |        | Thermometer : 54 dry, 52 wet, 10 a.m.                                                                                 |          |              |       |    |
| 16                | "            | 1,866  | 9.0        |        | 56 " 54 " 3 p.m.                                                                                                      |          |              |       |    |
| 17                | "            | 1,735  | 13.0       |        |                                                                                                                       |          |              |       |    |
| 18                | "            | 1,722  | 14.4       |        |                                                                                                                       |          |              |       |    |
| 19                | "            | 1,740  | 9.6        |        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.30</td><td>55</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.30 | 55 |
| Reading.          | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 30.30             | 55           |        |            |        |                                                                                                                       |          |              |       |    |
| 20                | "            | 1,742  | 14.4       |        | <table><tr><td>30.28</td><td>70</td></tr></table> 3 p.m.                                                              | 30.28    | 70           |       |    |
| 30.28             | 70           |        |            |        |                                                                                                                       |          |              |       |    |
| 21                | "            | 1,744  | 12.2       |        |                                                                                                                       |          |              |       |    |
| 22                | "            | 1,742  | 13.0       |        |                                                                                                                       |          |              |       |    |
| 23                | "            | 1,824  | 12.6       |        |                                                                                                                       |          |              |       |    |
| 24                | "            | 1,740  | 10.0       |        |                                                                                                                       |          |              |       |    |
| 25                | "            | 1,711  | 9.4        |        |                                                                                                                       |          |              |       |    |
| 26                | "            | 1,712  | 10.0       |        |                                                                                                                       |          |              |       |    |
| 27                | "            | 1,746  | 16.0       |        | There were four miss-fires during these rounds.                                                                       |          |              |       |    |
| 28                | "            | 1,734  | 12.4       |        |                                                                                                                       |          |              |       |    |
| 29                | "            | 1,764  | 8.0        |        |                                                                                                                       |          |              |       |    |
| 30                | "            | 1,753  | 9.6        |        |                                                                                                                       |          |              |       |    |
| 31                | "            | 1,812  | 10.4       |        |                                                                                                                       |          |              |       |    |
| 32                | "            | 1,739  | 13.0       |        |                                                                                                                       |          |              |       |    |
| 33                | "            | 1,768  | 10.0       |        |                                                                                                                       |          |              |       |    |

RANGE AND ACCURACY.—SHOT—*continued.*

| No. of Round. | Elevation. | Range. | 1st Graze. | Remarks.                 |
|---------------|------------|--------|------------|--------------------------|
|               |            |        | Right.     |                          |
|               | °          | Yards. | Yards.     |                          |
| 1             | 6          | 2,973  | 21.0       | <i>October 25, 1864.</i> |
| 2             | "          | 2,917  | 21.6       |                          |
| 3             | "          | 2,970  | 25.2       |                          |
| 4             | "          | 2,928  | 27.0       |                          |
| 5             | "          | 2,892  | 19.4       |                          |
| 6             | "          | 2,900  | 23.6       |                          |
| 7             | "          | 2,936  | 20.8       |                          |
| 8             | "          | 2,944  | 23.6       |                          |
| 9             | "          | 2,949  | 21.0       |                          |
| 10            | "          | 2,955  | 20.2       |                          |
| 11            | "          | 2,911  | 19.4       |                          |
| 12            | "          | 3,008  | 19.2       |                          |
| 13            | "          | 2,970  | 15.6       |                          |
| 14            | "          | 2,968  | 16.0       |                          |
| 15            | "          | 2,980  | 15.4       |                          |
| 16            | "          | 2,971  | 14.2       |                          |
| 17            | "          | 2,722  | 13.4       |                          |
| 18            | "          | 2,956  | 18.6       |                          |
| 19            | "          | 2,966  | 11.2       |                          |
| 20            | "          | 2,835  | 14.4       |                          |
| 21            | "          | 2,960  | 21.4       |                          |
| 22            | "          | 2,990  | 19.6       |                          |
| 23            | "          | 2,951  | 13.6       |                          |
| 24            | "          | 2,925  | 18.4       |                          |
| 25            | "          | 2,945  | 13.6       |                          |
| 26            | "          | 2,955  | 23.2       |                          |
| 27            | "          | 2,943  | 14.6       |                          |
| 28            | "          | 2,952  | 12.0       |                          |
| 29            | "          | 3,007  | 15.6       |                          |
| 30            | "          | 2,989  | 21.6       |                          |
| 31            | "          | 2,972  | 16.8       |                          |
| 32            | "          | 2,967  | 16.6       |                          |
| 33            | "          | 2,898  | 17.2       |                          |
| 34            | "          | 2,853  | 17.6       |                          |
| 35            | "          | 2,943  | 17.2       |                          |
| 36            | "          | 2,957  | 20.0       |                          |
| 37            | "          | 2,961  | 19.0       |                          |
| 38            | "          | 2,956  | 19.8       |                          |
| 39            | "          | 2,953  | 19.0       |                          |
| 40            | "          | 2,926  | 13.4       |                          |
| 41            | "          | 3,021  | 16.6       |                          |
| 42            | "          | 2,934  | 19.4       |                          |
| 43            | "          | 2,977  | 19.6       |                          |
| 44            | "          | 2,958  | 21.0       |                          |
|               |            |        |            | <i>October 26, 1864.</i> |
| 1             | 9          | 3,997  | 29.2       |                          |
| 2             | "          | 4,137  | 39.6       |                          |
| 3             | "          | 4,119  | 25.4       |                          |
| 4             | "          | 4,116  | 27.0       |                          |
| 5             | "          | 4,086  | 40.2       |                          |
| 6             | "          | 4,082  | 35.0       |                          |
| 7             | "          | 4,098  | 43.6       |                          |
| 8             | "          | 4,092  | 29.6       |                          |
| 9             | "          | 4,077  | 35.4       |                          |
| 10            | "          | 3,958  | 29.2       |                          |
| 11            | "          | 3,896  | 29.2       |                          |
| 12            | "          | 3,904  | 35.4       |                          |
| 13            | "          | 4,044  | 35.0       |                          |
| 14            | "          | 4,050  | 44.4       |                          |
| 15            | "          | 4,074  | 46.6       |                          |
| 16            | "          | 4,046  | 42.8       |                          |
| 17            | "          | 3,948  | 35.0       |                          |
| 18            | "          | 4,109  | 30.4       |                          |
| 19            | "          | 4,006  | 34.4       |                          |
| 20            | "          | 4,092  | 44.6       |                          |
| 21            | "          | 3,952  | 39.6       |                          |
| 22            | "          | 3,977  | 29.6       |                          |
| 23            | "          | 4,076  | 36.0       |                          |
| 24            | "          | 4,000  | 33.2       |                          |
| 25            | "          | 4,093  | 43.2       |                          |
| 26            | "          | 3,983  | 36.6       |                          |
| 27            | "          | 4,043  | 44.0       |                          |
| 28            | "          | 4,134  | 36.2       |                          |

The gun was 20 feet right of line.

Weather:—Hazy.

Wind:—Direction, E.S.E.; force, nil; 10 a.m.  
" E.; " 4; 3 p.m.Thermometer:—52 dry, 52 wet, 10 a.m.  
56 " 55 " 3 p.m.Barometer:—

|          |              |
|----------|--------------|
| Reading. | Temperature. |
| 29.55    | 52           |
| 29.45    | 56           |

10 a.m.  
3 p.m.

The gun was 20 feet right of line.

Weather:—Cloudy, 10 a.m.  
Hazy, 3 p.m.Wind:—Direction, E.; force, 3; 10 a.m.  
" E. by N. " 3; 3 p.m.Thermometer:—54 dry, 54 wet, 10 a.m.  
57 " 56 " 3 p.m.Barometer:—

|          |              |
|----------|--------------|
| Reading. | Temperature. |
| 29.38    | 55           |
| 29.30    | 55           |

10 a.m.  
3 p.m.

RANGE AND ACCURACY.—SHOT—*continued.*

| No. of Round. | Elevation.   | Range. | 1st Graze. | Remarks.                                                                                                              |          |              |       |    |
|---------------|--------------|--------|------------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|               |              |        | Right.     |                                                                                                                       |          |              |       |    |
|               | °            | Yards. | Yards.     |                                                                                                                       |          |              |       |    |
| 1             | 12           | 5,335  | 55.0       | March 2, 1865.                                                                                                        |          |              |       |    |
| 2             | "            | 5,237  | 59.0       |                                                                                                                       |          |              |       |    |
| 3             | "            | 5,200  | 42.0       |                                                                                                                       |          |              |       |    |
| 4             | "            | 5,385  | 48.0       |                                                                                                                       |          |              |       |    |
| 5             | "            | 5,300  | 45.0       | The gun was 19 feet right of line.                                                                                    |          |              |       |    |
| 6             | "            | 5,300  | 45.0       |                                                                                                                       |          |              |       |    |
| 7             | "            | 5,330  | 57.0       | Weather :—Foggy and raining, 10 a.m.                                                                                  |          |              |       |    |
| 8             | "            | 5,350  | 30.0       | Slight haze, 3 p.m.                                                                                                   |          |              |       |    |
| 9             | "            | 5,355  | 48.0       |                                                                                                                       |          |              |       |    |
| 10            | "            | 5,354  | 45.0       | Wind :—Direction, N.W. by W.; force, 4; 10 a.m.                                                                       |          |              |       |    |
| 11            | "            | 5,281  | 37.0       | " N.W. ; " 4; 3 p.m.                                                                                                  |          |              |       |    |
| 12            | "            | 5,240  | 41.0       |                                                                                                                       |          |              |       |    |
| 13            | "            | 5,327  | 49.0       | Thermometer :—44 dry, 44 wet, 10 a.m.                                                                                 |          |              |       |    |
| 14            | "            | 5,326  | 49.0       | 46 " 45 " 3 p.m.                                                                                                      |          |              |       |    |
| 15            | "            | 5,345  | 38.0       |                                                                                                                       |          |              |       |    |
| 16            | "            | 5,342  | 62.0       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.70</td><td>46</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.70 | 46 |
| Reading.      | Temperature. |        |            |                                                                                                                       |          |              |       |    |
| 29.70         | 46           |        |            |                                                                                                                       |          |              |       |    |
| 17            | "            | 5,276  | 49.0       | <table><tr><td>29.70</td><td>48</td></tr></table> 3 p.m.                                                              | 29.70    | 48           |       |    |
| 29.70         | 48           |        |            |                                                                                                                       |          |              |       |    |
| 18            | "            | 5,331  | 51.0       |                                                                                                                       |          |              |       |    |
| 19            | "            | 5,292  | 44.0       |                                                                                                                       |          |              |       |    |
| 20            | "            | 5,325  | 47.0       |                                                                                                                       |          |              |       |    |
| 21            | "            | 5,320  | 45.0       |                                                                                                                       |          |              |       |    |
| 22            | "            | 5,388  | 48.0       | October 27, 1864.                                                                                                     |          |              |       |    |
| 1             | 15           | 6,228  | 47.2       | The gun was 20 feet right of line.                                                                                    |          |              |       |    |
| 2             | "            | 6,273  | 57.4       | Weather :—Foggy.                                                                                                      |          |              |       |    |
| 3             | "            | 6,362  | 52.6       | Wind :—Direction, N.; force, 1; 10 a.m.                                                                               |          |              |       |    |
| 4             | "            | 6,372  | 35.0       | " W. by N.; " 2; 3 p.m.                                                                                               |          |              |       |    |
| 5             | "            | 6,391  | 41.0       | Thermometer :—55 dry, 54 wet, 10 a.m.                                                                                 |          |              |       |    |
| 6             | "            | 6,230  | 35.6       | 56 " 56 " 3 p.m.                                                                                                      |          |              |       |    |
| 7             | "            | 6,282  | 34.6       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.28</td><td>56</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.28 | 56 |
| Reading.      | Temperature. |        |            |                                                                                                                       |          |              |       |    |
| 29.28         | 56           |        |            |                                                                                                                       |          |              |       |    |
| 8             | "            | 6,398  | 36.2       | <table><tr><td>29.35</td><td>56</td></tr></table> 3 p.m.                                                              | 29.35    | 56           |       |    |
| 29.35         | 56           |        |            |                                                                                                                       |          |              |       |    |
|               |              |        |            | October 28, 1864.                                                                                                     |          |              |       |    |
| 1             | 15           | 5,950  | 49.0       | The gun was 20 feet right of line.                                                                                    |          |              |       |    |
| 2             | "            | 5,935  | 50.0       | Weather :—Thick haze on water, 10 a.m.                                                                                |          |              |       |    |
| 3             | "            | 6,014  | 52.0       | Slight haze, 3 p.m.                                                                                                   |          |              |       |    |
| 4             | "            | 6,030  | 48.0       |                                                                                                                       |          |              |       |    |
| 5             | "            | 5,958  | 52.0       | Wind :—Direction, N.E. by E.; force, 1; 10 a.m.                                                                       |          |              |       |    |
| 6             | "            | 5,950  | 56.0       | " E. by N.; " 3; 3 p.m.                                                                                               |          |              |       |    |
| 7             | "            | 5,740  | 45.0       |                                                                                                                       |          |              |       |    |
| 8             | "            | 6,000  | 48.0       | Thermometer :—56 dry, 55 wet, 10 a.m.                                                                                 |          |              |       |    |
| 9             | "            | 5,934  | 49.0       | 57 " 56 " 3 p.m.                                                                                                      |          |              |       |    |
| 10            | "            | 6,020  | 46.0       |                                                                                                                       |          |              |       |    |
| 11            | "            | 5,954  | 44.0       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.55</td><td>58</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.55 | 58 |
| Reading.      | Temperature. |        |            |                                                                                                                       |          |              |       |    |
| 29.55         | 58           |        |            |                                                                                                                       |          |              |       |    |
| 12            | "            | 5,850  | 47.0       | <table><tr><td>29.55</td><td>57</td></tr></table> 3 p.m.                                                              | 29.55    | 57           |       |    |
| 29.55         | 57           |        |            |                                                                                                                       |          |              |       |    |
|               |              |        |            | June 21, 1865.                                                                                                        |          |              |       |    |
| 1             | 15           | 5,958  | 30.6       |                                                                                                                       |          |              |       |    |
| 2             | "            | 6,246  | 36.2       |                                                                                                                       |          |              |       |    |
| 3             | "            | 6,276  | 37.0       |                                                                                                                       |          |              |       |    |
| 4             | "            | 6,255  | 45.0       |                                                                                                                       |          |              |       |    |
| 5             | "            | 6,206  | 46.8       |                                                                                                                       |          |              |       |    |
| 6             | "            | 6,254  | 38.0       |                                                                                                                       |          |              |       |    |
| 7             | "            | 6,270  | 46.0       | Weather :—Clear.                                                                                                      |          |              |       |    |
| 8             | "            | 6,245  | 49.8       |                                                                                                                       |          |              |       |    |
| 9             | "            | 6,239  | 27.6       | Wind :—Direction, S.E. by S.; force, 2; 10 a.m.                                                                       |          |              |       |    |
| 10            | "            | 6,329  | 43.0       | " " " 2; 3 p.m.                                                                                                       |          |              |       |    |
| 11            | "            | 6,264  | 48.0       |                                                                                                                       |          |              |       |    |
| 12            | "            | 6,220  | 42.6       | Thermometer :—67 dry, 64 wet, 10 a.m.                                                                                 |          |              |       |    |
| 13            | "            | 6,294  | 25.0       | 70 " 66 " 3 p.m.                                                                                                      |          |              |       |    |
| 14            | "            | 6,300  | 24.4       |                                                                                                                       |          |              |       |    |
| 15            | "            | 6,270  | 35.0       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.40</td><td>67</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.40 | 67 |
| Reading.      | Temperature. |        |            |                                                                                                                       |          |              |       |    |
| 30.40         | 67           |        |            |                                                                                                                       |          |              |       |    |
| 16            | "            | 6,200  | 46.6       | <table><tr><td>30.40</td><td>67</td></tr></table> 3 p.m.                                                              | 30.40    | 67           |       |    |
| 30.40         | 67           |        |            |                                                                                                                       |          |              |       |    |
| 17            | "            | 6,210  | 51.4       |                                                                                                                       |          |              |       |    |
| 18            | "            | 6,215  | 47.0       |                                                                                                                       |          |              |       |    |
| 19            | "            | 6,300  | 34.8       |                                                                                                                       |          |              |       |    |
| 20            | "            | 6,250  | 36.4       |                                                                                                                       |          |              |       |    |
| 21            | "            | 6,243  | 33.8       |                                                                                                                       |          |              |       |    |
| 22            | "            | 6,285  | 33.0       |                                                                                                                       |          |              |       |    |
| 23            | "            | 6,260  | 23.0       |                                                                                                                       |          |              |       |    |



RANGE AND ACCURACY.—SHOT—*continued*

| No. of Round.      | Elevation.   | Range.          | 1st Graze.     |        | Remarks.                                                                                                                                                                                |          |              |  |       |    |         |       |    |        |
|--------------------|--------------|-----------------|----------------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|--|-------|----|---------|-------|----|--------|
|                    |              |                 |                | Right. |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| November 22, 1864. |              |                 |                |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1                  | 21           | Yards.<br>7,880 | Yards.<br>93.0 |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 2                  | "            | 8,050           | 96.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3                  | "            | 7,988           | 106.0          |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 4                  | "            | 8,041           | 98.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 5                  | "            | 7,942           | 109.0          |        | The gun was on the line.                                                                                                                                                                |          |              |  |       |    |         |       |    |        |
| 6                  | "            | 8,066           | 92.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 7                  | "            | 8,014           | 75.0           |        | Weather :—Hazy and raining, 10 a.m.                                                                                                                                                     |          |              |  |       |    |         |       |    |        |
| 8                  | "            | 7,988           | 83.0           |        | Clearing up, 3 p.m.                                                                                                                                                                     |          |              |  |       |    |         |       |    |        |
| 9                  | "            | 7,856           | 86.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 10                 | "            | 8,040           | 109.0          |        | Wind :—Direction, W.S.W.; force, 3; 10 a.m.                                                                                                                                             |          |              |  |       |    |         |       |    |        |
| 11                 | "            | 7,844           | 76.0           |        | " N.W. by W. " 5; 3 p.m.                                                                                                                                                                |          |              |  |       |    |         |       |    |        |
| 12                 | "            | 7,922           | 70.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 13                 | "            | 7,894           | 70.0           |        | Thermometer :—49 dry, 49 wet, 10 a.m.                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 14                 | "            | 7,908           | 81.0           |        | 49 " 47 " 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 15                 | "            | 7,940           | 97.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 16                 | "            | 7,911           | 85.0           |        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>29.65</td><td>51</td><td>10 a.m.</td></tr><tr><td>29.55</td><td>52</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 29.65 | 51 | 10 a.m. | 29.55 | 52 | 3 p.m. |
| Reading.           | Temperature. |                 |                |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29.65              | 51           | 10 a.m.         |                |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29.55              | 52           | 3 p.m.          |                |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 17                 | "            | 7,844           | 61.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 18                 | "            | 7,909           | 67.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19                 | "            | 8,016           | 82.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20                 | "            | 8,078           | 69.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| February 21, 1865. |              |                 |                |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1                  | 3            | 1,528           | 13.6           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 2                  | "            | 1,487           | 12.6           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3                  | "            | 1,543           | 10.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 4                  | "            | 1,549           | 9.6            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 5                  | "            | 1,505           | 9.0            |        | The gun was 19 feet right of line.                                                                                                                                                      |          |              |  |       |    |         |       |    |        |
| 6                  | "            | 1,556           | 12.4           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 7                  | "            | 1,498           | 10.0           |        | Cartridges filled with L.G. powder.                                                                                                                                                     |          |              |  |       |    |         |       |    |        |
| 8                  | "            | 1,597           | 13.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 9                  | "            | 1,608           | 11.4           |        | Weather :—Hazy, 10 a.m.                                                                                                                                                                 |          |              |  |       |    |         |       |    |        |
| 10                 | "            | 1,515           | 14.4           |        | Hazy and snowing, 3 p.m.                                                                                                                                                                |          |              |  |       |    |         |       |    |        |
| 11                 | "            | 1,557           | 12.4           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 12                 | "            | 1,528           | 12.6           |        | Wind :—Direction, N.W.; force, 3; 10 a.m.                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 13                 | "            | 1,636           | 9.6            |        | " W.; " 3; 3 p.m.                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 14                 | "            | 1,677           | 13.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 15                 | "            | 1,588           | 12.6           |        | Thermometer :—32 dry, 31 wet, 10 a.m.                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 16                 | "            | 1,547           | 11.8           |        | 34 " 32 " 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 17                 | "            | 1,548           | 12.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 18                 | "            | 1,593           | 13.8           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19                 | "            | 1,560           | 19.8           |        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>30.38</td><td>37</td><td>10 a.m.</td></tr><tr><td>30.30</td><td>39</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 30.38 | 37 | 10 a.m. | 30.30 | 39 | 3 p.m. |
| Reading.           | Temperature. |                 |                |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 30.38              | 37           | 10 a.m.         |                |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 30.30              | 39           | 3 p.m.          |                |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20                 | "            | 1,648           | 11.4           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 21                 | "            | 1,524           | 10.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 22                 | "            | 1,516           | 12.2           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| March 10, 1865.    |              |                 |                |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1                  | 6            | 2,742           | 11.4           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 2                  | "            | 2,777           | 8.2            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3                  | "            | 2,779           | 10.2           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 4                  | "            | 2,835           | 8.0            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 5                  | "            | 2,850           | 4.8            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 6                  | "            | 2,812           | 6.4            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 7                  | "            | 2,825           | 9.4            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 8                  | "            | 2,860           | 4.4            |        | The gun was 19 feet right of line.                                                                                                                                                      |          |              |  |       |    |         |       |    |        |
| 9                  | "            | 2,777           | 8.4            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 10                 | "            | 2,779           | 12.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 11                 | "            | 2,750           | 12.4           |        | Cartridges filled with L.G. powder.                                                                                                                                                     |          |              |  |       |    |         |       |    |        |
| 12                 | "            | 2,762           | 10.0           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 13                 | "            | 2,789           | 10.4           |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 14                 | "            | 2,810           | 8.4            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 15                 | "            | 2,755           | 7.4            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 16                 | "            | 2,764           | 8.6            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 17                 | "            | 2,762           | 8.6            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 18                 | "            | 2,788           | 5.4            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19                 | "            | 2,804           | 8.0            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20                 | "            | 2,761           | 8.2            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 21                 | "            | 2,745           | 4.6            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 22                 | "            | 2,694           | 3.8            |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |



RANGE AND ACCURACY.—SHOT—*continued.*

AFTER FIRING 3,000 ROUNDS.

| No. of Rounds. | Elevation.   | Range. | First Graze. |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|----------------|--------------|--------|--------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|                |              |        | Right.       | Left.  |                                                                                                                                                         |          |              |       |    |       |    |
|                | °            | Yards. | Yards.       | Yards. | June 19, 1865.                                                                                                                                          |          |              |       |    |       |    |
| 1              | 6            | 2,959  | 12·8         | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 2              | "            | 2,958  | 6·6          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3              | "            | 2,803  | 0·8          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 4              | "            | 2,831  | 9·2          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 5              | "            | 2,769  | 8·6          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 6              | "            | 2,906  | 10·0         | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 7              | "            | 2,916  | 9·4          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 8              | "            | 2,851  | 10·0         | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 9              | "            | 2,932  | 5·4          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 10             | "            | 2,948  | 8·8          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 11             | "            | 2,968  | 7·0          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 12             | "            | 2,931  | 11·2         | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 13             | "            | 2,848  | 6·0          | —      | Weather :—Clear.                                                                                                                                        |          |              |       |    |       |    |
| 14             | "            | 2,846  | 8·4          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 15             | "            | 2,925  | 2·0          | —      | Wind :—Direction, E.N.E. ; force, 2 ; 10 a.m.                                                                                                           |          |              |       |    |       |    |
| 16             | "            | 2,984  | 1·4          | —      | " S.E. by E. ;   " 2 ; 3 p.m.                                                                                                                           |          |              |       |    |       |    |
| 17             | "            | 2,950  | 6·8          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 18             | "            | 2,871  | —            | 0·8    | Thermometer :—56 dry, 54 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 19             | "            | 2,959  | 7·4          | —      | 61   " 59   " 3 p.m.                                                                                                                                    |          |              |       |    |       |    |
| 20             | "            | 2,957  | 3·6          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 21             | "            | 2,712  | —            | 0·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 22             | "            | 2,934  | —            | 1·2    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29·90</td><td>58</td></tr><tr><td>30·35</td><td>60</td></tr></table> 10 a.m. | Reading. | Temperature. | 29·90 | 58 | 30·35 | 60 |
| Reading.       | Temperature. |        |              |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·90          | 58           |        |              |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·35          | 60           |        |              |        |                                                                                                                                                         |          |              |       |    |       |    |
| 23             | "            | 2,966  | 7·0          | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 24             | "            | 2,907  | 0·4          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 25             | "            | 2,958  | 2·0          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 26             | "            | 2,930  | 1·0          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 27             | "            | 2,891  | 9·8          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 28             | "            | 2,896  | 0·2          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 29             | "            | 2,951  | —            | 0·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 30             | "            | 2,944  | 4·0          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 31             | "            | 2,843  | 1·6          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 32             | "            | 2,967  | 9·8          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 33             | "            | 2,920  | 5·4          | —      |                                                                                                                                                         |          |              |       |    |       |    |

COMMON SHELL (WEIGHTED WITH SAND).

PARTICULARS OF SHELL AND AMMUNITION.

N.B.—The figures in *Italics* are the rounds struck out by the competitors as abnormal shots.

SHOEBURYNESS.

Weight, 67 lbs. 7 oz., empty.

Diameter { major, 5.46 in.  
              minor, 4.98 in.

Length, 17.985 inches.

Bursting charge, 2 lbs. 14 oz.

Firing from the rear vent ; cartridge adapted for the purpose.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                          |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | In Line.   | Right. | Left.  |                                                                                                                                                                   |          |              |       |    |       |    |
|               | °            | Yards. |            | Yards. | Yards. | November 8, 1864.                                                                                                                                                 |          |              |       |    |       |    |
| 1             | 1            | 852    | —          | —      | 1.8    | The gun hung fire at the second round, and went off as the man was inserting the tube.                                                                            |          |              |       |    |       |    |
| 2             | "            | 842    | —          | —      | 0.4    |                                                                                                                                                                   |          |              |       |    |       |    |
| 3             | "            | 924    | —          | —      | 0.4    |                                                                                                                                                                   |          |              |       |    |       |    |
| 4             | "            | 884    | —          | —      | 3.4    |                                                                                                                                                                   |          |              |       |    |       |    |
| 5             | "            | 877    | —          | —      | 2.0    |                                                                                                                                                                   |          |              |       |    |       |    |
| 6             | "            | 876    | —          | —      | 4.0    |                                                                                                                                                                   |          |              |       |    |       |    |
| 7             | "            | 938    | —          | —      | 3.2    |                                                                                                                                                                   |          |              |       |    |       |    |
| 8             | "            | 858    | —          | —      | 2.0    |                                                                                                                                                                   |          |              |       |    |       |    |
| 9             | "            | 889    | —          | —      | 0.4    |                                                                                                                                                                   |          |              |       |    |       |    |
| 10            | "            | 930    | —          | —      | 2.0    | The gun was on the line.                                                                                                                                          |          |              |       |    |       |    |
| 11            | "            | 854    | —          | —      | 2.2    |                                                                                                                                                                   |          |              |       |    |       |    |
| 12            | "            | 884    | —          | —      | 2.0    | Weather :—Thick haze, 10 a.m.<br>Foggy, 3 p.m.                                                                                                                    |          |              |       |    |       |    |
| 13            | "            | 858    | —          | —      | 1.8    |                                                                                                                                                                   |          |              |       |    |       |    |
| 14            | "            | 933    | —          | —      | 0.6    | Wind :—Direction, N.N.W. ; force, 3 ; 10 a.m.<br>" " N. " 1 ; 3 p.m.                                                                                              |          |              |       |    |       |    |
| 15            | "            | 908    | —          | —      | 2.0    |                                                                                                                                                                   |          |              |       |    |       |    |
| 16            | "            | 908    | —          | —      | 1.6    | Thermometer :—39 dry, 38 wet, 10 a.m.<br>45 " 44 " 3 p.m.                                                                                                         |          |              |       |    |       |    |
| 17            | "            | 880    | —          | —      | 2.4    |                                                                                                                                                                   |          |              |       |    |       |    |
| 18            | "            | 870    | —          | —      | 4.2    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.10</td><td>43</td></tr><tr><td>30.08</td><td>46</td></tr></table> 10 a.m.<br>3 p.m. | Reading. | Temperature. | 30.10 | 43 | 30.08 | 46 |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 30.10         | 43           |        |            |        |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 30.08         | 46           |        |            |        |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 19            | "            | 919    | Yes.       | —      | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 20            | "            | 866    | —          | —      | 0.4    |                                                                                                                                                                   |          |              |       |    |       |    |
| 21            | "            | 846    | —          | —      | 2.6    |                                                                                                                                                                   |          |              |       |    |       |    |
| 22            | "            | 852    | —          | —      | 2.0    |                                                                                                                                                                   |          |              |       |    |       |    |
| 23            | "            | 862    | —          | —      | 1.0    |                                                                                                                                                                   |          |              |       |    |       |    |
| 24            | "            | 886    | —          | —      | 0.2    |                                                                                                                                                                   |          |              |       |    |       |    |
| 25            | "            | 910    | —          | —      | 1.0    |                                                                                                                                                                   |          |              |       |    |       |    |
| 26            | "            | 902    | —          | —      | 1.6    |                                                                                                                                                                   |          |              |       |    |       |    |
| 27            | "            | 862    | —          | —      | 2.8    |                                                                                                                                                                   |          |              |       |    |       |    |
| 28            | "            | 854    | —          | —      | 2.2    |                                                                                                                                                                   |          |              |       |    |       |    |
| 29            | "            | 887    | —          | —      | 2.2    |                                                                                                                                                                   |          |              |       |    |       |    |
| 30            | "            | 837    | —          | —      | 2.0    |                                                                                                                                                                   |          |              |       |    |       |    |
| 31            | "            | 885    | —          | —      | 0.2    |                                                                                                                                                                   |          |              |       |    |       |    |
| 32            | "            | 858    | —          | —      | 1.0    |                                                                                                                                                                   |          |              |       |    |       |    |
| 33            | "            | 868    | —          | —      | 2.0    |                                                                                                                                                                   |          |              |       |    |       |    |

RANGE AND ACCURACY.—COMMON SHELL—*continued.*

| No. of Round.      | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|--------------------|--------------|--------|------------|--------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|                    |              |        | In Line.   | Right. | Left.  |                                                                                                                                                         |          |              |       |    |       |    |
|                    | °            | Yards. |            | Yards. | Yards. | November 22, 1864.                                                                                                                                      |          |              |       |    |       |    |
| 1                  | 4            | 1,970  | —          | 18.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 2                  | "            | 1,923  | —          | 21.2   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3                  | "            | 1,986  | —          | 21.6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 4                  | "            | 1,978  | —          | 22.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 5                  | "            | 2,023  | —          | 18.6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 6                  | "            | 1,896  | —          | 18.2   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 7                  | "            | 1,958  | —          | 23.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 8                  | "            | 1,940  | —          | 19.4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 9                  | "            | 1,988  | —          | 19.6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 10                 | "            | 1,982  | —          | 22.2   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 11                 | "            | 1,935  | —          | 19.6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 12                 | "            | 2,000  | —          | 21.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 13                 | "            | 1,958  | —          | 21.6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 14                 | "            | 1,935  | —          | 22.0   | —      | Five tubes missed fire, and on the charge being drawn the vent was found to be clear.                                                                   |          |              |       |    |       |    |
| 15                 | "            | 1,950  | —          | 19.2   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 16                 | "            | 1,988  | —          | 19.4   | —      | The gun was 59 feet right of line.                                                                                                                      |          |              |       |    |       |    |
| 17                 | "            | 2,006  | —          | 17.6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 18                 | "            | 1,969  | —          | 18.0   | —      | Weather :—Hazy and raining, 10 a.m.                                                                                                                     |          |              |       |    |       |    |
| 19                 | "            | 1,997  | —          | 21.6   | —      | Clearing up, 3 p.m.                                                                                                                                     |          |              |       |    |       |    |
| 20                 | "            | 2,050  | —          | 20.4   | —      | Wind :—Direction, W.S.W. ; force, 3 ; 10 a.m.                                                                                                           |          |              |       |    |       |    |
| 21                 | "            | 2,023  | —          | 17.2   | —      | " N.W. by W. " 5 ; 3 p.m.                                                                                                                               |          |              |       |    |       |    |
| 22                 | "            | 2,050  | —          | 18.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 23                 | "            | 2,073  | —          | 19.0   | —      | Thermometer :—49 dry, 49 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 24                 | "            | 2,042  | —          | 20.0   | —      | 49 " 47 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 25                 | "            | 1,985  | —          | 22.2   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 26                 | "            | 2,046  | —          | 20.2   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.65</td><td>51</td></tr><tr><td>29.55</td><td>52</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.65 | 51 | 29.55 | 52 |
| Reading.           | Temperature. |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29.65              | 51           |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29.55              | 52           |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 27                 | "            | 2,041  | —          | 14.6   | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 28                 | "            | 2,094  | —          | 14.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 29                 | "            | 1,915  | —          | 21.4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 30                 | "            | 1,988  | —          | 18.2   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 31                 | "            | 1,992  | —          | 19.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 32                 | "            | 1,992  | —          | 19.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 33                 | "            | 1,980  | —          | 20.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| November 21, 1864. |              |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 1                  | 7            | 3,362  | —          | 24.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 2                  | "            | 3,290  | —          | 24.4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3                  | "            | 3,361  | —          | 28.4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 4                  | "            | 3,430  | —          | 29.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 5                  | "            | 3,381  | —          | 23.4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 6                  | "            | 3,274  | —          | 32.2   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 7                  | "            | 3,346  | —          | 29.4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 8                  | "            | 3,281  | —          | 25.4   | —      | One shell broke up in the gun.                                                                                                                          |          |              |       |    |       |    |
| 9                  | "            | 3,396  | —          | 30.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 10                 | "            | 3,340  | —          | 29.4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 11                 | "            | 3,398  | —          | 27.6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 12                 | "            | 3,357  | —          | 24.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 13                 | "            | 3,388  | —          | 29.4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 14                 | "            | 3,317  | —          | 25.8   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 15                 | "            | 3,230  | —          | 21.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 16                 | "            | 3,250  | —          | 28.0   | —      | The gun was 59 feet right of line.                                                                                                                      |          |              |       |    |       |    |
| 17                 | "            | 3,197  | —          | 32.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 18                 | "            | 3,331  | —          | 23.8   | —      | Weather :—Hazy.                                                                                                                                         |          |              |       |    |       |    |
| 19                 | "            | 3,381  | —          | 25.6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 20                 | "            | 3,300  | —          | 28.0   | —      | Wind :—Direction, N.W. by W. ; force, 2 ; 10 a.m.                                                                                                       |          |              |       |    |       |    |
| 21                 | "            | 3,352  | —          | 27.2   | —      | " S.W. by W. " 3 ; 3 p.m.                                                                                                                               |          |              |       |    |       |    |
| 22                 | "            | 3,348  | —          | 28.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 23                 | "            | 3,346  | —          | 30.4   | —      | Thermometer :—45 dry, 44 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 24                 | "            | 3,334  | —          | 26.0   | —      | 49 " 48 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 25                 | "            | 3,367  | —          | 20.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 26                 | "            | 3,264  | —          | 26.0   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.88</td><td>49</td></tr><tr><td>29.90</td><td>51</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.88 | 49 | 29.90 | 51 |
| Reading.           | Temperature. |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29.88              | 49           |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29.90              | 51           |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 27                 | "            | 3,300  | —          | 23.2   | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 28                 | "            | 3,334  | —          | 27.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 29                 | "            | 3,306  | —          | 15.4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 30                 | "            | 3,330  | —          | 20.4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 31                 | "            | 3,314  | —          | 20.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 32                 | "            | 3,344  | —          | 23.2   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 33                 | "            | 3,386  | —          | 19.4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 34                 | "            | 3,335  | —          | 23.2   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 35                 | "            | 3,300  | —          | 25.6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 36                 | "            | 3,356  | —          | 21.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 37                 | "            | 3,370  | —          | 19.2   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 38                 | "            | 3,380  | —          | 20.0   | —      |                                                                                                                                                         |          |              |       |    |       |    |

RANGE AND ACCURACY.—COMMON SHELL—continued.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | In Line.   | Right. | Left.  |                                                                                                                                                         |          |              |       |    |       |    |
|               | °            | Yards. |            | Yards. | Yards. |                                                                                                                                                         |          |              |       |    |       |    |
|               |              |        |            |        |        | November 10, 1864.                                                                                                                                      |          |              |       |    |       |    |
| 1             | 10           | 4,248  | —          | 46·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "            | 4,180  | —          | 34·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 4,210  | —          | 30·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "            | 4,196  | —          | 42·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "            | 4,232  | —          | 36·4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 6             | "            | 4,218  | —          | 48·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 7             | "            | —      | —          | —      | —      | Broke up in the gun.                                                                                                                                    |          |              |       |    |       |    |
| 8             | "            | 4,154  | —          | 42·4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 9             | "            | 4,170  | —          | 33·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 10            | "            | 4,406  | —          | 43·0   | —      | At the 10th round this gun missed fire, the charge had to be drawn and the vent drilled out.                                                            |          |              |       |    |       |    |
| 11            | "            | 4,318  | —          | 39·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "            | 4,290  | —          | 40·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 13            | "            | 4,356  | —          | 42·0   | —      | The gun was 9 feet right of line.                                                                                                                       |          |              |       |    |       |    |
| 14            | "            | 4,256  | —          | 48·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 15            | "            | 4,369  | —          | 29·0   | —      | Weather :—Clear.                                                                                                                                        |          |              |       |    |       |    |
| 16            | "            | 4,191  | —          | 36·0   | —      | Wind :—Direction, E.S.E. ; force, 5 ; 10 a.m.                                                                                                           |          |              |       |    |       |    |
| 17            | "            | 4,214  | —          | 42·4   | —      | " E. by S. ; " 3 ; 3 p.m.                                                                                                                               |          |              |       |    |       |    |
| 18            | "            | 4,055  | —          | 35·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 19            | "            | 4,155  | —          | 40·0   | —      | Thermometer :—43 dry, 41 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 20            | "            | 4,218  | —          | 35·6   | —      | 43 " 41 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 21            | "            | 4,118  | —          | 41·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 22            | "            | 4,256  | —          | 48·4   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·10</td><td>47</td></tr><tr><td>30·05</td><td>46</td></tr></table> 10 a.m. | Reading. | Temperature. | 30·10 | 47 | 30·05 | 46 |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·10         | 47           |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·05         | 46           |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 23            | "            | 4,224  | —          | 37·0   | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 24            | "            | 4,266  | —          | 41·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 25            | "            | 4,264  | —          | 48·4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 26            | "            | 4,258  | —          | 42·4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 27            | "            | 4,199  | —          | 33·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 28            | "            | 4,188  | —          | 45·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 29            | "            | 4,418  | —          | 47·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 30            | "            | 4,216  | —          | 34·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 31            | "            | 4,242  | —          | 38·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 32            | "            | 4,310  | —          | 37·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
|               |              |        |            |        |        | November 21, 1864.                                                                                                                                      |          |              |       |    |       |    |
| 1             | 17           | 6,760  | —          | 66·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "            | 6,792  | —          | 57·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 6,797  | —          | 45·0   | —      | B. guns. The gun was on the line.                                                                                                                       |          |              |       |    |       |    |
| 4             | "            | 6,730  | —          | 47·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "            | 6,754  | —          | 65·0   | —      | Weather :—Hazy, 10 a.m.                                                                                                                                 |          |              |       |    |       |    |
| 6             | "            | 6,711  | —          | 48·0   | —      | " 3 p.m.                                                                                                                                                |          |              |       |    |       |    |
| 7             | "            | 6,782  | —          | 68·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 8             | "            | 6,683  | —          | 58·0   | —      | Wind :—Direction, N.W. by W. ; force, 2 ; 10 a.m.                                                                                                       |          |              |       |    |       |    |
| 9             | "            | 6,771  | —          | 64·0   | —      | " S.W. by W. ; " 3 ; 3 p.m.                                                                                                                             |          |              |       |    |       |    |
| 10            | "            | 6,739  | —          | 58·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 11            | "            | 6,694  | —          | 68·0   | —      | Thermometer :—45 dry, 44 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 12            | "            | 6,708  | —          | 62·0   | —      | 49 " 48 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 13            | "            | 6,764  | —          | 58·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 14            | "            | 6,731  | —          | 66·0   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29·88</td><td>49</td></tr><tr><td>29·90</td><td>51</td></tr></table> 10 a.m. | Reading. | Temperature. | 29·88 | 49 | 29·90 | 51 |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·88         | 49           |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·90         | 51           |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 15            | "            | 6,712  | —          | 73·0   | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 16            | "            | 6,790  | —          | 67·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 17            | "            | 6,707  | —          | 64·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 18            | "            | 6,692  | —          | 56·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 19            | "            | 6,806  | —          | 45·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 20            | "            | 6,724  | —          | 62·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |

RANGE AND ACCURACY—*continued*.

## BOXER'S SHRAPNEL SHELL (WEIGHTED WITH SAND).

## PARTICULARS OF SHELL AND AMMUNITION.

N.B.—The figures in *Italics* are the rounds struck out by the competitors as abnormal shots.

SHOEBURYNESS.

Weight, 67·7 lbs.

Diameter { major, 5·46 in.  
minor, 4·98 in.

Length, 15·58 in.

No. of bullets, 199.

Bursting charge, 3 or 6 oz.

Firing from rear vent ; cartridge adapted for the purpose.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                                                                                     |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | Right.     | Left.  |                                                                                                                                                                              |          |              |       |    |       |    |
|               | °            | Yards. | Yards.     | Yards. | October 11, 1864.                                                                                                                                                            |          |              |       |    |       |    |
| 1             | 2            | 1,302  | 9·4        | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 2             | "            | 1,320  | 8·2        | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 3             | "            | 1,398  | 9·4        | —      | The gun was 20 feet to right of line.                                                                                                                                        |          |              |       |    |       |    |
| 4             | "            | 1,395  | 10·0       | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 5             | "            | 1,380  | 10·6       | —      | Weather :—Thick haze.                                                                                                                                                        |          |              |       |    |       |    |
| 6             | "            | 1,345  | 7·2        | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 7             | "            | 1,348  | 9·4        | —      | Wind :—Direction, N. ; force, 2 ; 10 a.m.                                                                                                                                    |          |              |       |    |       |    |
| 8             | "            | 1,390  | 12·0       | —      | " " 2 ; 3 p.m.                                                                                                                                                               |          |              |       |    |       |    |
| 9             | "            | 1,403  | 11·2       | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 10            | "            | 1,347  | 10·6       | —      | Thermometer :—52 dry, 50 wet, 10 a.m.                                                                                                                                        |          |              |       |    |       |    |
| 11            | "            | 1,322  | 10·0       | —      | 55 " 52 " 3 p.m.                                                                                                                                                             |          |              |       |    |       |    |
| 12            | "            | 1,374  | 11·2       | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 13            | "            | 1,281  | 10·6       | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·42</td><td>54</td></tr><tr><td>30·45</td><td>68</td></tr></table> 10 a.m.                      | Reading. | Temperature. | 30·42 | 54 | 30·45 | 68 |
| Reading.      | Temperature. |        |            |        |                                                                                                                                                                              |          |              |       |    |       |    |
| 30·42         | 54           |        |            |        |                                                                                                                                                                              |          |              |       |    |       |    |
| 30·45         | 68           |        |            |        |                                                                                                                                                                              |          |              |       |    |       |    |
| 14            | "            | 1,396  | 9·4        | —      | 3 p.m.                                                                                                                                                                       |          |              |       |    |       |    |
| 15            | "            | 1,395  | 7·4        | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 16            | "            | 1,338  | 10·0       | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 17            | "            | 1,319  | 10·2       | —      | Corresponding round, shunt, broke up.                                                                                                                                        |          |              |       |    |       |    |
| 18            | "            | 1,427  | 11·0       | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 19            | "            | 1,298  | 9·2        | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 20            | "            | 1,314  | 8·0        | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 21            | "            | 1,318  | 10·0       | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 22            | "            | 1,410  | 9·0        | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 23            | "            | 1,293  | 10·2       | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 24            | "            | —      | —          | —      | Broke up in gun.                                                                                                                                                             |          |              |       |    |       |    |
| 25            | "            | 1,366  | 10·2       | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 26            | "            | 1,372  | 9·4        | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 27            | "            | 1,323  | 7·0        | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 28            | "            | 1,358  | 11·4       | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 29            | "            | 1,389  | 10·2       | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 30            | "            | 1,380  | 12·0       | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 31            | "            | 1,370  | 11·4       | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 32            | "            | 1,348  | 7·6        | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 33            | "            | —      | —          | —      | Broke up in gun.                                                                                                                                                             |          |              |       |    |       |    |
| 34            | "            | 1,346  | 6·4        | —      | At the 36th round the point of the pricker broke in the vent and spiked the gun. The vent was taken out, the obstruction removed, and the firing was stopped in consequence. |          |              |       |    |       |    |
| 35            | "            | 1,344  | 13·0       | —      |                                                                                                                                                                              |          |              |       |    |       |    |
| 36            | "            | 1,364  | 12·2       | —      |                                                                                                                                                                              |          |              |       |    |       |    |



RANGE AND ACCURACY.—BOXER'S SHRAPNEL SHELL—*continued.*

| No. of Round.            | Elevation. | Range. | 1st Graze. |        | Remarks.                                                                  |
|--------------------------|------------|--------|------------|--------|---------------------------------------------------------------------------|
|                          |            |        | Right.     | Left.  |                                                                           |
|                          | °          | Yards. | Yards.     | Yards. |                                                                           |
| <i>November 9, 1864.</i> |            |        |            |        |                                                                           |
| 1                        | 5          | 2,556  | 7.0        | —      | The gun was on the line.                                                  |
| 2                        | "          | 2,592  | 2.0        | —      | Weather :—Clear.                                                          |
| 3                        | "          | 2,518  | 0.4        | —      | Wind :—Direction, N.E. by E. ; force, 3 ; 10 a.m.                         |
| 4                        | "          | 2,559  | 7.2        | —      | " E. by N. " 4 ; 3 p.m.                                                   |
| 5                        | "          | 2,537  | 6.2        | —      | Thermometer :—42 dry, 41 wet, 10 a.m.                                     |
| 6                        | "          | 2,582  | 4.8        | —      | 46 " 43 " 3 p.m.                                                          |
| 7                        | "          | 2,522  | 6.2        | —      | Barometer :— <sup>Reading.</sup> 30.15 <sup>Temperature.</sup> 44 10 a.m. |
| 8                        | "          | 2,582  | 3.0        | —      | 30.12 46 3 p.m.                                                           |
| 9                        | "          | 2,541  | 3.0        | —      |                                                                           |
| 10                       | "          | 2,515  | 4.6        | —      |                                                                           |
| 11                       | "          | 2,556  | 3.0        | —      |                                                                           |
| 12                       | "          | 2,541  | 4.8        | —      |                                                                           |
| 13                       | "          | —      | —          | —      | Broke up in the gun.                                                      |
| 14                       | "          | —      | —          | —      | " "                                                                       |
| 15                       | "          | —      | —          | —      | " "                                                                       |
| 16                       | "          | 2,549  | 4.4        | —      |                                                                           |
| 17                       | "          | 2,581  | 6.0        | —      |                                                                           |
| 18                       | "          | 2,529  | 3.6        | —      |                                                                           |
| 19                       | "          | 2,562  | —          | 0.2    |                                                                           |
| 20                       | "          | —      | —          | —      | Broke up in the gun.                                                      |
| 21                       | "          | —      | —          | —      | " "                                                                       |
| 22                       | "          | 2,563  | 3.4        | —      |                                                                           |
| 23                       | "          | —      | —          | —      | Broke up in the gun.                                                      |
| 24                       | "          | 2,610  | 1.6        | —      |                                                                           |
| 25                       | "          | —      | —          | —      | Broke up in the gun.                                                      |
| <i>October 13, 1864.</i> |            |        |            |        |                                                                           |
| 1                        | 8          | 3,775  | 33.0       | —      | Broke up.                                                                 |
| 2                        | "          | 3,742  | 32.4       | —      | The gun was 20 feet right of line.                                        |
| 3                        | "          | 3,561  | 28.0       | —      | Broke up.                                                                 |
| 4                        | "          | 3,712  | 34.8       | —      | Weather :—Clear, 10 a.m.                                                  |
| 5                        | "          | 3,764  | 24.4       | —      | Thick haze, 3 p.m.                                                        |
| 6                        | "          | 3,786  | 32.0       | —      | Broke up in the gun.                                                      |
| 7                        | "          | —      | —          | —      | Wind :—Direction, N. by W. ; force, 3 ; 10 a.m.                           |
| 8                        | "          | 3,764  | 34.6       | —      | " N.N.W. " 2 ; 3 p.m.                                                     |
| 9                        | "          | 3,746  | 26.0       | —      | Thermometer :—53 dry, 51 wet, 10 a.m.                                     |
| 10                       | "          | 3,750  | 37.8       | —      | 59 " 55 " 3 p.m.                                                          |
| 11                       | "          | 3,730  | 35.8       | —      | Broke up in the gun.                                                      |
| 12                       | "          | —      | —          | —      | Barometer :— <sup>Reading.</sup> 30.10 <sup>Temperature.</sup> 60 10 a.m. |
| 13                       | "          | 3,787  | 25.0       | —      | 30.10 60 3 p.m.                                                           |
| 14                       | "          | 3,770  | 31.0       | —      |                                                                           |
| 15                       | "          | —      | —          | —      | Broke up in the gun.                                                      |
| 16                       | "          | 3,732  | 24.0       | —      |                                                                           |
| 17                       | "          | 3,730  | 39.0       | —      |                                                                           |
| 18                       | "          | 3,765  | 33.6       | —      |                                                                           |
| 19                       | "          | 3,746  | 34.6       | —      | Broke up.                                                                 |
| 20                       | "          | 3,715  | 38.0       | —      |                                                                           |
| 21                       | "          | 3,811  | 36.4       | —      |                                                                           |
| 22                       | "          | 3,742  | 28.0       | —      | Broke up.                                                                 |
| 23                       | "          | 3,700  | 33.6       | —      | Broke up.                                                                 |
| 24                       | "          | 3,796  | 27.6       | —      |                                                                           |
| 25                       | "          | 3,727  | 34.2       | —      |                                                                           |

RANGE AND ACCURACY.—BOXER'S SHRAPNEL SHELL—*continued.*

| No. of Round.      | Elevation.   | Range.   | 1st Graze. |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|--------------------|--------------|----------|------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|                    |              |          | Right.     | Left.  |                                                                                                                                                         |          |              |       |    |       |    |
| November 9, 1864.  |              |          |            |        |                                                                                                                                                         |          |              |       |    |       |    |
|                    | °            | Yards.   | Yards.     | Yards. |                                                                                                                                                         |          |              |       |    |       |    |
| 1                  | 11           | 4,731    | 54.6       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 2                  | "            | 4,791    | 43.8       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3                  | "            | 4,695    | 47.4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 4                  | "            | 4,791    | 50.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 5                  | "            | 4,721    | 49.4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 6                  | "            | 4,670    | 45.8       | —      | The gun was 9 feet right of line.                                                                                                                       |          |              |       |    |       |    |
| 7                  | "            | 4,659    | 53.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 8                  | "            | 4,640    | 50.6       | —      | Weather :—Clear.                                                                                                                                        |          |              |       |    |       |    |
| 9                  | "            | 4,661    | 47.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 10                 | "            | 4,710    | 57.2       | —      | Wind :—Direction, N.E. by E. ; force, 3 ; 10 a.m.                                                                                                       |          |              |       |    |       |    |
| 11                 | "            | 4,666    | 47.6       | —      | " E. by N. ; " 4 ; 3 p.m.                                                                                                                               |          |              |       |    |       |    |
| 12                 | "            | 4,706    | 57.4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 13                 | "            | 4,648    | 50.0       | —      | Thermometer :—42 dry, 41 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 14                 | "            | 4,633    | 48.0       | —      | 46 " 43 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 15                 | "            | 4,587    | 47.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 16                 | "            | 4,718    | 49.0       | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.15</td><td>44</td></tr><tr><td>30.12</td><td>46</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.15 | 44 | 30.12 | 46 |
| Reading.           | Temperature. |          |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30.15              | 44           |          |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30.12              | 46           |          |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 17                 | "            | 4,607    | 55.4       | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 18                 | "            | 4,657    | 50.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 19                 | "            | 4,615    | 43.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 20                 | "            | 4,550    | 44.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 21                 | "            | 4,665    | 50.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 22                 | "            | 4,539    | 50.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 23                 | "            | 4,627    | 51.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 24                 | "            | 4,635    | 59.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 25                 | "            | 4,566    | 46.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 26                 | "            | 4,606    | 45.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 27                 | "            | —        | —          | —      | Broke up in the gun.                                                                                                                                    |          |              |       |    |       |    |
| 28                 | "            | —        | —          | —      | " "                                                                                                                                                     |          |              |       |    |       |    |
| 29                 | "            | 4,562    | 39.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 30                 | "            | 4,668    | 43.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 31                 | "            | 4,632    | 48.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 32                 | "            | 4,634    | 44.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 33                 | "            | 4,655    | 54.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 34                 | "            | 4,618    | 46.8       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 35                 | "            | —        | —          | —      | Broke up in the gun.                                                                                                                                    |          |              |       |    |       |    |
| 36                 | "            | 4,567    | 42.2       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 37                 | "            | 4,606    | 40.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 38                 | "            | 4,542    | 48.4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 39                 | "            | 4,650    | 49.2       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 40                 | "            | —        | —          | —      | Broke up in the gun.                                                                                                                                    |          |              |       |    |       |    |
| 41                 | "            | 4,528    | 57.2       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 42                 | "            | 4,571    | 44.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 43                 | "            | 4,641    | 54.4       | —      | Broke up in the gun.                                                                                                                                    |          |              |       |    |       |    |
| 44                 | "            | —        | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| November 18, 1864. |              |          |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 1                  | 19           | 7,804    | 33.0       | —      | The gun was on the line.                                                                                                                                |          |              |       |    |       |    |
| 2                  | "            | 7,687    | 34.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3                  | "            | 7,586    | 35.0       | —      | Weather :—Clear, 10 a.m.                                                                                                                                |          |              |       |    |       |    |
| 4                  | "            | 7,818    | 31.0       | —      | Slight haze, 3 p.m.                                                                                                                                     |          |              |       |    |       |    |
| 5                  | "            | Not seen | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 6                  | "            | 7,650    | 34.0       | —      | Wind :—Direction, W. ; force, 7 ; 10 a.m.                                                                                                               |          |              |       |    |       |    |
| 7                  | "            | 7,672    | 33.0       | —      | " N.W. by N. ; force, 6 ; 3 p.m.                                                                                                                        |          |              |       |    |       |    |
| 8                  | "            | 7,260    | 40.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 9                  | "            | 7,612    | 28.0       | —      | Thermometer :—51 dry, 49 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 10                 | "            | 7,749    | 36.0       | —      | 51 " 50 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 11                 | "            | 7,700    | 31.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 12                 | "            | 7,813    | 27.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| *13                | "            | 7,656    | 33.0       | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.30</td><td>51</td></tr><tr><td>29.30</td><td>51</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.30 | 51 | 29.30 | 51 |
| Reading.           | Temperature. |          |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29.30              | 51           |          |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29.30              | 51           |          |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 14                 | "            | 7,800    | 32.0       | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 15                 | "            | 7,654    | 33.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 16                 | "            | 7,666    | 41.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 17                 | "            | 7,710    | 33.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| *18                | "            | 7,813    | 42.0       | —      | *Corresponding rounds, shunt, lost.                                                                                                                     |          |              |       |    |       |    |
| 19                 | "            | 7,645    | 34.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 20                 | "            | 7,700    | 28.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |



DESTRUCTIVE EFFECT OF BOXER'S SHRAPNEL SHELL AGAINST  
TARGETS REPRESENTING TROOPS IN LINE AND IN COLUMN;  
3 oz. BURSTER.

SHELL PRACTICE.

To burst on graze.

BOXER'S SHRAPNEL SHELL.

November 17, 1864.

RANGE, 800 yards.

Firing carried on against three lines of 2-inch  
targets 9 feet square, 6 targets in each line, 10 yards  
interval between the lines.

|                           |           | Through. | Lodged. | Struck. |                                                                   |           | Through. | Lodged. | Struck. |
|---------------------------|-----------|----------|---------|---------|-------------------------------------------------------------------|-----------|----------|---------|---------|
| Struck 25 yards<br>short. | 1st line. |          |         |         | Struck 18 yards<br>short.                                         | 1st line. |          |         |         |
|                           | 1 target  | 0        | 0       | 0       |                                                                   | 1 target  | 0        | 0       | 0       |
|                           | 2 "       | 9        | 0       | 0       |                                                                   | 2 "       | 0        | 0       | 0       |
|                           | 3 "       | 24       | 0       | 0       |                                                                   | 3 "       | 12       | 0       | 2       |
|                           | 4 "       | 16       | 0       | 0       |                                                                   | 4 "       | 30       | 1       | 5       |
|                           | 5 "       | 3        | 0       | 0       |                                                                   | 5 "       | 18       | 1       | 1       |
|                           | 6 "       | 1        | 0       | 0       |                                                                   | 6 "       | 0        | 0       | 0       |
|                           | 2nd line. |          |         |         |                                                                   | 2nd line. |          |         |         |
|                           | 1 target  | 0        | 0       | 0       |                                                                   | 1 target  | 0        | 0       | 0       |
|                           | 2 "       | 0        | 0       | 0       |                                                                   | 2 "       | 0        | 0       | 0       |
|                           | 3 "       | 5        | 0       | 2       |                                                                   | 3 "       | 2        | 0       | 1       |
|                           | 4 "       | 3        | 0       | 2       |                                                                   | 4 "       | 4        | 2       | 0       |
|                           | 5 "       | 0        | 0       | 0       |                                                                   | 5 "       | 3        | 1       | 1       |
|                           | 6 "       | 0        | 0       | 0       |                                                                   | 6 "       | 5        | 0       | 0       |
|                           | 3rd line. |          |         |         | Struck 17 yards<br>short.                                         | 3rd line. |          |         |         |
|                           | 1 target  | 0        | 0       | 0       |                                                                   | 1 target  | 0        | 0       | 0       |
|                           | 2 "       | 0        | 0       | 0       |                                                                   | 2 "       | 0        | 0       | 0       |
|                           | 3 "       | 0        | 1       | 1       |                                                                   | 3 "       | 1        | 0       | 0       |
|                           | 4 "       | 2        | 0       | 1       |                                                                   | 4 "       | 2        | 2       | 2       |
|                           | 5 "       | 1        | 0       | 0       |                                                                   | 5 "       | 0        | 0       | 0       |
|                           | 6 "       | 1        | 0       | 0       |                                                                   | 6 "       | 1        | 0       | 0       |
|                           | 1st line. |          |         |         |                                                                   | 1st line. |          |         |         |
|                           | 1 target  | 0        | 0       | 0       |                                                                   | 1 target  | 0        | 0       | 0       |
|                           | 2 "       | 0        | 0       | 0       |                                                                   | 2 "       | 0        | 0       | 0       |
|                           | 3 "       | 0        | 1       | 1       |                                                                   | 3 "       | 3        | 0       | 1       |
|                           | 4 "       | 2        | 0       | 1       |                                                                   | 4 "       | 132      | 1       | 1       |
|                           | 5 "       | 1        | 0       | 0       |                                                                   | 5 "       | 31       | 0       | 2       |
|                           | 6 "       | 1        | 0       | 0       |                                                                   | 6 "       | 0        | 0       | 0       |
|                           | 2nd line. |          |         |         |                                                                   | 2nd line. |          |         |         |
|                           | 1 target  | 0        | 0       | 0       |                                                                   | 1 target  | 0        | 0       | 0       |
|                           | 2 "       | 0        | 0       | 0       |                                                                   | 2 "       | 0        | 0       | 1       |
|                           | 3 "       | 0        | 1       | 1       |                                                                   | 3 "       | 6        | 0       | 0       |
|                           | 4 "       | 2        | 0       | 1       |                                                                   | 4 "       | 52       | 0       | 3       |
|                           | 5 "       | 1        | 0       | 0       |                                                                   | 5 "       | 4        | 0       | 0       |
|                           | 6 "       | 1        | 0       | 0       |                                                                   | 6 "       | 1        | 0       | 0       |
|                           | 3rd line. |          |         |         |                                                                   | 3rd line. |          |         |         |
|                           | 1 target  | 0        | 0       | 0       |                                                                   | 1 target  | 0        | 0       | 0       |
|                           | 2 "       | 0        | 0       | 0       |                                                                   | 2 "       | 0        | 0       | 0       |
|                           | 3 "       | 0        | 1       | 1       |                                                                   | 3 "       | 3        | 0       | 0       |
|                           | 4 "       | 2        | 0       | 1       |                                                                   | 4 "       | 14       | 1       | 0       |
|                           | 5 "       | 1        | 0       | 0       |                                                                   | 5 "       | 1        | 0       | 0       |
|                           | 6 "       | 1        | 0       | 0       |                                                                   | 6 "       | 2        | 0       | 1       |
| Struck 58 yards<br>short. | 1st line. |          |         |         | Struck at 23 yards<br>and passed<br>through 1st and<br>2nd lines. | 1st line. |          |         |         |
|                           | 1 target  | 0        | 0       | 0       |                                                                   | 1 target  | } Nil.   | Nil.    | Nil.    |
|                           | 2 "       | 13       | 1       | 0       |                                                                   | 2 "       |          |         |         |
|                           | 3 "       | 18       | 0       | 0       |                                                                   | 3 "       |          |         |         |
|                           | 4 "       | 3        | 0       | 2       |                                                                   | 4 "       |          |         |         |
|                           | 5 "       | 2        | 0       | 0       |                                                                   | 5 "       |          |         |         |
|                           | 6 "       | 0        | 0       | 0       |                                                                   | 6 "       |          |         |         |
|                           | 2nd line. |          |         |         |                                                                   | 2nd line. |          |         |         |
|                           | 1 target  | 0        | 0       | 0       |                                                                   | 1 target  | } Nil.   | Nil.    | Nil.    |
|                           | 2 "       | 9        | 1       | 0       |                                                                   | 2 "       |          |         |         |
|                           | 3 "       | 4        | 1       | 1       |                                                                   | 3 "       |          |         |         |
|                           | 4 "       | 1        | 0       | 1       |                                                                   | 4 "       |          |         |         |
|                           | 5 "       | 0        | 0       | 0       |                                                                   | 5 "       |          |         |         |
|                           | 6 "       | 0        | 0       | 0       |                                                                   | 6 "       |          |         |         |
|                           | 3rd line. |          |         |         |                                                                   | 3rd line. |          |         |         |
|                           | 1 target  | 0        | 0       | 0       |                                                                   | 1 target  | 0        | 0       | 0       |
|                           | 2 "       | 7        | 0       | 0       |                                                                   | 2 "       | 0        | 0       | 0       |
|                           | 3 "       | 3        | 0       | 1       |                                                                   | 3 "       | 0        | 0       | 0       |
|                           | 4 "       | 2        | 0       | 0       |                                                                   | 4 "       | 178      | 1       | 2       |
|                           | 5 "       | 0        | 0       | 0       |                                                                   | 5 "       | 0        | 0       | 0       |
|                           | 6 "       | 0        | 0       | 0       |                                                                   | 6 "       | 0        | 0       | 0       |

## BOXER'S SHRAPNEL SHELL—continued.

|                                                                               |           | Through.                  | Lodged. | Struck. |                                 |           | Through. | Lodged. | Struck. |  |
|-------------------------------------------------------------------------------|-----------|---------------------------|---------|---------|---------------------------------|-----------|----------|---------|---------|--|
| Struck 29 yards short.                                                        | 1st line. |                           |         |         | Struck 13 ft. above the ground. | 3rd line. |          |         |         |  |
|                                                                               | 1 target  | 0                         | 0       | 0       |                                 | 1 target  | 3        | 2       | 3       |  |
|                                                                               | 2 "       | 5                         | 0       | 0       |                                 | 2 "       | 7        | 0       | 1       |  |
|                                                                               | 3 "       | 32                        | 0       | 1       |                                 | 3 "       | 10       | 5       | 0       |  |
|                                                                               | 4 "       | 102                       | 2       | 3       |                                 | 4 "       | 4        | 1       | 0       |  |
|                                                                               | 5 "       | 23                        | 0       | 3       |                                 | 5 "       | 12       | 1       | 1       |  |
|                                                                               | 6 "       | 0                         | 0       | 0       |                                 | 6 "       | 0        | 1       | 0       |  |
|                                                                               | 2nd line. |                           |         |         |                                 | 1st line. |          |         |         |  |
|                                                                               | 1 target  | 0                         | 0       | 0       |                                 | 1 target  | 14       | 0       | 0       |  |
|                                                                               | 2 "       | 7                         | 0       | 0       |                                 | 2 "       | 13       | 0       | 0       |  |
|                                                                               | 3 "       | 14                        | 1       | 0       |                                 | 3 "       | 14       | 1       | 0       |  |
|                                                                               | 4 "       | 45                        | 1       | 3       |                                 | 4 "       | 14       | 0       | 0       |  |
|                                                                               | 5 "       | 39                        | 1       | 2       |                                 | 5 "       | 14       | 0       | 0       |  |
|                                                                               | 6 "       | 0                         | 0       | 0       |                                 | 6 "       | 5        | 0       | 0       |  |
|                                                                               | 3rd line. |                           |         |         |                                 | 2nd line. |          |         |         |  |
|                                                                               | 1 target  | 0                         | 0       | 0       |                                 | 1 target  | 9        | 0       | 0       |  |
|                                                                               | 2 "       | 5                         | 0       | 0       |                                 | 2 "       | 16       | 0       | 0       |  |
|                                                                               | 3 "       | 18                        | 0       | 1       |                                 | 3 "       | 11       | 0       | 0       |  |
|                                                                               | 4 "       | 23                        | 0       | 1       |                                 | 4 "       | 10       | 0       | 0       |  |
|                                                                               | 5 "       | 42                        | 1       | 0       |                                 | 5 "       | 5        | 1       | 0       |  |
|                                                                               | 6 "       | 6                         | 0       | 0       |                                 | 6 "       | 9        | 0       | 0       |  |
| Struck 21 yards short.                                                        | 1st line. |                           |         |         | Struck 12 ft. above the ground. | 3rd line. |          |         |         |  |
|                                                                               | 1 target  | Passed through in a mass. |         |         |                                 | 1 target  | 1        | 0       | 1       |  |
|                                                                               | 2 "       |                           |         |         |                                 | 2 "       | 5        | 2       | 0       |  |
|                                                                               | 3 "       |                           |         |         |                                 | 3 "       | 3        | 1       | 1       |  |
|                                                                               | 4 "       |                           |         |         |                                 | 4 "       | 1        | 1       | 1       |  |
|                                                                               | 5 "       |                           |         |         |                                 | 5 "       | 5        | 1       | 0       |  |
|                                                                               | 6 "       |                           |         |         |                                 | 6 "       | 1        | 4       | 0       |  |
|                                                                               | 2nd line. |                           |         |         |                                 | 1st line. |          |         |         |  |
|                                                                               | 1 target  | 0                         | 0       | 0       |                                 | 1 target  | 0        | 0       | 0       |  |
|                                                                               | 2 "       | 0                         | 0       | 0       |                                 | 2 "       | 10       | 0       | 0       |  |
|                                                                               | 3 "       | 39                        | 0       | 0       |                                 | 3 "       | 10       | 0       | 0       |  |
|                                                                               | 4 "       | 0                         | 0       | 0       |                                 | 4 "       | 13       | 0       | 1       |  |
|                                                                               | 5 "       | 1                         | 0       | 0       |                                 | 5 "       | 7        | 1       | 2       |  |
|                                                                               | 6 "       | 0                         | 0       | 0       |                                 | 6 "       | 13       | 1       | 0       |  |
|                                                                               | 3rd line. |                           |         |         |                                 | 2nd line. |          |         |         |  |
|                                                                               | 1 target  | 0                         | 0       | 0       |                                 | 1 target  | 0        | 0       | 0       |  |
|                                                                               | 2 "       | 0                         | 0       | 0       |                                 | 2 "       | 6        | 0       | 0       |  |
|                                                                               | 3 "       | 15                        | 1       | 0       |                                 | 3 "       | 9        | 2       | 1       |  |
|                                                                               | 4 "       | 0                         | 0       | 0       |                                 | 4 "       | 10       | 2       | 2       |  |
|                                                                               | 5 "       | 0                         | 0       | 0       |                                 | 5 "       | 3        | 2       | 1       |  |
|                                                                               | 6 "       | 0                         | 0       | 0       |                                 | 6 "       | 4        | 1       | 0       |  |
| December 19, 1864.                                                            |           |                           |         |         |                                 |           |          |         |         |  |
| The screen placed so as to burst the shell 100 yards in front of the targets. |           |                           |         |         |                                 |           |          |         |         |  |
|                                                                               |           | Through.                  | Lodged. | Struck. |                                 |           |          |         |         |  |
| Struck 11 ft. above the ground.                                               | 1st line. |                           |         |         | Struck 8 ft. above the ground.  | 1st line. |          |         |         |  |
|                                                                               | 1 target  | 4                         | 0       | 0       |                                 | 1 target  | 1        | 0       | 0       |  |
|                                                                               | 2 "       | 13                        | 0       | 0       |                                 | 2 "       | 9        | 0       | 0       |  |
|                                                                               | 3 "       | 13                        | 0       | 0       |                                 | 3 "       | 38       | 1       | 0       |  |
|                                                                               | 4 "       | 16                        | 0       | 0       |                                 | 4 "       | 34       | 0       | 3       |  |
|                                                                               | 5 "       | 21                        | 0       | 0       |                                 | 5 "       | 36       | 0       | 0       |  |
|                                                                               | 6 "       | 7                         | 0       | 1       |                                 | 6 "       | 5        | 0       | 0       |  |
|                                                                               | 2nd line. |                           |         |         |                                 |           |          |         |         |  |
|                                                                               | 1 target  | 4                         | 0       | 0       |                                 |           |          |         |         |  |
|                                                                               | 2 "       | 15                        | 0       | 0       |                                 |           |          |         |         |  |
|                                                                               | 3 "       | 15                        | 0       | 0       |                                 |           |          |         |         |  |
|                                                                               | 4 "       | 6                         | 1       | 0       |                                 |           |          |         |         |  |
|                                                                               | 5 "       | 15                        | 1       | 0       |                                 |           |          |         |         |  |
|                                                                               | 6 "       | 9                         | 0       | 0       |                                 |           |          |         |         |  |
| The screen placed so as to burst the shell 50 yards in front of the targets.  |           |                           |         |         |                                 |           |          |         |         |  |
|                                                                               |           | Through.                  | Lodged. | Struck. |                                 |           |          |         |         |  |

BOXER'S SHRAPNEL SHELL—*continued.*

December 19, 1864.

|                                 |           | Through. | Lodged. | Struck. |                                |           | Through                                       | Lodged. | Struck. |
|---------------------------------|-----------|----------|---------|---------|--------------------------------|-----------|-----------------------------------------------|---------|---------|
| Struck 8½ ft. above the ground. | 2nd line. |          |         |         | Struck 8 in. above the ground. | 1st line. |                                               |         |         |
|                                 | 1 target  | 5        | 2       | 0       |                                | 1 target  | 3                                             | 0       | 0       |
|                                 | 2 "       | 29       | 0       | 3       |                                | 2 "       | 2                                             | 0       | 0       |
|                                 | 3 "       | 24       | 0       | 3       |                                | 3 "       | 26                                            | 0       | 0       |
|                                 | 4 "       | 22       | 1       | 2       |                                | 4 "       | 22                                            | 0       | 0       |
|                                 | 5 "       | 10       | 0       | 2       |                                | 5 "       | 0                                             | 0       | 0       |
|                                 | 6 "       | 1        | 0       | 0       |                                | 6 "       | 0                                             | 0       | 0       |
|                                 | 3rd line. |          |         |         |                                | 2nd line. |                                               |         |         |
|                                 | 1 target  | 0        | 0       | 0       |                                | 1 target  | 6                                             | 0       | 1       |
|                                 | 2 "       | 9        | 2       | 1       |                                | 2 "       | 1                                             | 0       | 0       |
|                                 | 3 "       | 17       | 5       | 2       |                                | 3 "       | 18                                            | 1       | 0       |
|                                 | 4 "       | 7        | 4       | 1       |                                | 4 "       | 9                                             | 0       | 1       |
|                                 | 5 "       | 18       | 6       | 7       |                                | 5 "       | 0                                             | 0       | 0       |
|                                 | 6 "       | 7        | 0       | 1       |                                | 6 "       | 0                                             | 0       | 0       |
|                                 | 1st line. |          |         |         |                                | 3rd line. |                                               |         |         |
|                                 | 1 target  | 1        | 1       | 0       |                                | 1 target  | 0                                             | 0       | 0       |
|                                 | 2 "       | 7        | 0       | 0       |                                | 2 "       | 0                                             | 0       | 0       |
|                                 | 3 "       | 67       | 2       | 1       |                                | 3 "       | 3                                             | 0       | 0       |
| Struck 6 ft. above the ground.  | 4 "       | 59       | 0       | 2       | Struck 5 ft. above the ground. | 4 "       | 6                                             | 0       | 0       |
|                                 | 5 "       | 33       | 0       | 0       |                                | 5 "       | 0                                             | 0       | 0       |
|                                 | 6 "       | 0        | 0       | 0       |                                | 6 "       | 2                                             | 0       | 0       |
|                                 | 2nd line. |          |         |         |                                | 1st line. |                                               |         |         |
|                                 | 1 target  | 0        | 0       | 0       |                                | 1 target  | 0                                             | 0       | 0       |
|                                 | 2 "       | 18       | 1       | 0       |                                | 2 "       | 0                                             | 0       | 0       |
|                                 | 3 "       | 38       | 3       | 1       |                                | 3 "       | 0                                             | 0       | 0       |
|                                 | 4 "       | 45       | 2       | 1       |                                | 4 "       | 79, and large pieces of the target torn away. |         |         |
|                                 | 5 "       | 34       | 1       | 0       |                                | 5 "       | 0                                             | 0       | 0       |
|                                 | 6 "       | 0        | 1       | 1       |                                | 6 "       | 0                                             | 0       | 0       |
|                                 | 3rd line. |          |         |         |                                | 2nd line. |                                               |         |         |
|                                 | 1 target  | 1        | 0       | 0       |                                | 1 target  | 0                                             | 2       | 0       |
|                                 | 2 "       | 9        | 1       | 0       |                                | 2 "       | 4                                             | 0       | 0       |
|                                 | 3 "       | 23       | 6       | 2       |                                | 3 "       | 122                                           | 0       | 0       |
|                                 | 4 "       | 22       | 2       | 3       |                                | 4 "       | 18                                            | 0       | 0       |
|                                 | 5 "       | 25       | 2       | 0       |                                | 5 "       | 0                                             | 0       | 0       |
|                                 | 6 "       | 6        | 2       | 1       |                                | 6 "       | 0                                             | 0       | 0       |
|                                 | 1st line. |          |         |         |                                | 3rd line. |                                               |         |         |
|                                 | 1 target  | 1        | 0       | 0       |                                | 1 target  | 0                                             | 0       | 0       |
|                                 | 2 "       | 22       | 0       | 0       |                                | 2 "       | 33                                            | 6       | 4       |
|                                 | 3 "       | 49       | 2       | 3       |                                | 3 "       | 91                                            | 3       | 4       |
|                                 | 4 "       | 44       | 0       | 3       |                                | 4 "       | 18                                            | 0       | 1       |
|                                 | 5 "       | 19       | 0       | 0       |                                | 5 "       | 0                                             | 0       | 0       |
|                                 | 6 "       | 2        | 0       | 0       |                                | 6 "       | 0                                             | 0       | 0       |
|                                 | 2nd line. |          |         |         |                                |           |                                               |         |         |
|                                 | 1 target  | 3        | 0       | 0       |                                |           |                                               |         |         |
|                                 | 2 "       | 14       | 2       | 2       |                                |           |                                               |         |         |
|                                 | 3 "       | 43       | 1       | 4       |                                |           |                                               |         |         |
|                                 | 4 "       | 25       | 0       | 0       |                                |           |                                               |         |         |
|                                 | 5 "       | 19       | 1       | 1       |                                |           |                                               |         |         |
|                                 | 6 "       | 1        | 0       | 1       |                                |           |                                               |         |         |
|                                 | 3rd line. |          |         |         |                                |           |                                               |         |         |
|                                 | 1 target  | 4        | 1       | 1       |                                |           |                                               |         |         |
|                                 | 2 "       | 7        | 7       | 1       |                                |           |                                               |         |         |
|                                 | 3 "       | 24       | 5       | 1       |                                |           |                                               |         |         |
|                                 | 4 "       | 19       | 3       | 1       |                                |           |                                               |         |         |
|                                 | 5 "       | 9        | 6       | 2       |                                |           |                                               |         |         |
|                                 | 6 "       | 1        | 1       | 0       |                                |           |                                               |         |         |

The shells were fired through a screen 4 inches in thickness, so as to burst 10 yards in front of the 1st line of targets.

Three lines of targets 10 yards apart.

## PENETRATION INTO MASONRY.

DESCRIPTION OF TOWER.—(See *Lithograph opposite.*)

The Tower was built in the year 1804, and is stated to have cost 3,000*l*. It is of brick, able to accommodate 20 men, with magazine space for 80 barrels or 70 cases of powder. Like all the Martello Towers on this part of the coast, it is designed for one gun. The wall on the side fired at is 7 feet 6 inches thick at the level of the ground, and 5 feet 9 inches at the spring of the vault, which is 19 feet from the ground. It is 31 feet 6 inches high, but receives considerable support, at 12 feet above the ground, from the joists of the floor, which radiate from a central pillar and abut against it. To a certain extent also the basement floor, at 2½ feet above the ground, may be regarded as a support. In appearance the Tower was perfectly sound, the brickwork having been protected by a coating of plaster. The parapet, 5½ feet high and 5 feet thick, was coped with Bramleyfall stone, in blocks containing 7 or 8 cubic feet; a step 2 feet high, round the interior, served the double purpose of a banquette and of a support for the front racers of a rear pivot-traversing platform turning the entire circle. The racer itself was laid on granite curb-stones of about half a ton weight each. Thus a great solidity characterized the whole structure. The roof was formed of a bomb-proof vault, supported in the centre by a pillar 4 feet in diameter, turned in three courses of bricks, and surmounted by an equal thickness of ordinary brickwork, giving altogether about 5 feet of masonry over the crown of the arch. The diameter of the whole at the top was 40 feet, and nearly 46 feet at the bottom.

*Bexhill, October 19, 1864.*

RANGE, 750 yards.

Centre gun.

*1st Round—Common Shell*, filled with sand.

Struck 4 feet 6 inches below the floor line, 15 feet left of door; passed through the wall, the pieces of the shell found inside; wall, 7 feet thick.

*2nd Round.*

Passed through the same hole as No. 1; cut a piece out of the centre supporting column; shell broke up.

*1st Round—Solid Shot.*

Struck in the same hole as No. 1 muzzle-loading Armstrong; penetration, 7 feet; the shot found reversed against granite curb, with the head pointing towards the guns.

*2nd Round.*

Struck exactly in the same relative position as the muzzle-loading Armstrong No. 1; shot passed through the wall 6 feet 8 inches thick and indented the opposite wall to a depth of 8 inches.

*3rd Round.*

Struck on broken-up part of parapet; passed through and fell expended on the other side of the platform.

*October 20, 1864.*

*4th Round.*

Passed through a broken part; struck the granite arch; shot broke up.

*5th Round.*

Struck well on the solid; broke through the crown of the arch, the shot having been deflected downwards; shot fell inside exhausted; penetration, 7 feet 3 inches.

COMMON SHELL—BOXER'S TIME FUZE, 5 in.

Bursting charge, 2 lbs. 10½ oz.

*1st Round.*

Shell penetrated 5 feet and burst; broke away a cavity, inside 18 inches in diameter; diameter outside, 1 foot; the wall bulged inside from the ground to 3 feet above it; some portion of brickwork scaled away.

*2nd Round.*

Hit on the damaged part of wall made by No. 1 breech-loading common shell, live; penetration, 5 feet 4 inches; shell burst; area of damage inside, 4 feet × 4 feet × 9 inches.

Struck the inside of the sea face, the land face having been destroyed on the level of the spring of the arch; masonry, 9½ feet thick; three bricks on the outside face loosened, one cracked, and a slight crack on the face of the tower.

## COMMON CASE.

December 21, 1864.

At a line of six 9-feet targets.

RANGE, 500 yards.

| —              | —        | Through. | Lodged. | Struck. |
|----------------|----------|----------|---------|---------|
| 1st round -    | 1 target | 1        | 1       | 0       |
|                | 2 "      | 0        | 0       | 1       |
| 3° elevation.  | 3 "      | 1        | 0       | 1       |
|                | 4 "      | 3        | 5       | 3       |
|                | 5 "      | 0        | 5       | 5       |
|                | 6 "      | 3        | 3       | 4       |
| 2nd round -    | 1 target | 1        | 1       | 1       |
|                | 2 "      | 1        | 1       | 1       |
| 3½° elevation. | 3 "      | 0        | 2       | 0       |
|                | 4 "      | 2        | 2       | 0       |
|                | 5 "      | 1        | 3       | 4       |
|                | 6 "      | 0        | 1       | 3       |
| 3rd round -    | 1 target | 0        | 3       | 3       |
|                | 2 "      | 0        | 2       | 0       |
| 3½° elevation. | 3 "      | 0        | 2       | 0       |
|                | 4 "      | 1        | 5       | 2       |
|                | 5 "      | 0        | 1       | 0       |
|                | 6 "      | 2        | 2       | 2       |
| 4th round -    | 1 target | 1        | 2       | 0       |
|                | 2 "      | 1        | 4       | 2       |
| 2° elevation.  | 3 "      | 1        | 3       | 3       |
|                | 4 "      | 3        | 8       | 5       |
|                | 5 "      | 1        | 3       | 5       |
|                | 6 "      | 3        | 7       | 0       |
| 5th round -    | 1 target | 1        | 7       | 7       |
|                | 2 "      | 1        | 4       | 3       |
| 1½° elevation. | 3 "      | 0        | 7       | 3       |
|                | 4 "      | 4        | 5       | 4       |
|                | 5 "      | 3        | 6       | 9       |
|                | 6 "      | 2        | 5       | 3       |
| 6th round -    | 1 target | 3        | 5       | 2       |
|                | 2 "      | 2        | 3       | 7       |
| 1½° elevation. | 3 "      | 0        | 4       | 5       |
|                | 4 "      | 2        | 8       | 5       |
|                | 5 "      | 1        | 5       | 5       |
|                | 6 "      | 1        | 5       | 6       |
| 7th round -    | 1 target | 1        | 3       | 5       |
|                | 2 "      | 1        | 4       | 7       |
| 1½° elevation. | 3 "      | 1        | 2       | 6       |
|                | 4 "      | 8        | 2       | 11      |
|                | 5 "      | 5        | 2       | 8       |
|                | 6 "      | 3        | 2       | 5       |

Vent stopped up, charge had to be drawn, a piece of the serge of the cartridge found in the vent.

RANGE, 300 yards.

| —             | —        | Through. | Lodged. | Struck. |
|---------------|----------|----------|---------|---------|
| 1st round -   | 1 target | 28       | 6       | 1       |
|               | 2 "      | 36       | 16      | 0       |
| ½° elevation. | 3 "      | 78       | 20      | 5       |
|               | 4 "      | 84       | 12      | 5       |
|               | 5 "      | 86       | 6       | 2       |
|               | 6 "      | 31       | 5       | 2       |
| 2nd round -   | 1 target | 24       | 6       | 2       |
|               | 2 "      | 50       | 10      | 1       |
| 1° elevation. | 3 "      | 67       | 8       | 1       |
|               | 4 "      | 69       | 9       | 7       |
|               | 5 "      | 50       | 9       | 4       |
|               | 6 "      | 29       | 1       | 1       |

The above is the record after three rounds had been fired at each elevation.

RANGE, 100 yards.

| —           | —        | Through. | Lodged. | Struck. |
|-------------|----------|----------|---------|---------|
| 1st round - | 1 target | 0        | 0       | 0       |
|             | 2 "      | 7        | 1       | 0       |
|             | 3 "      | 237      | 3       | 2       |
|             | 4 "      | 262      | 2       | 3       |
|             | 5 "      | 29       | 0       | 0       |
|             | 6 "      | 4        | 0       | 1       |
| 2nd round - | 1 target | 2        | 0       | 0       |
|             | 2 "      | 20       | 2       | 0       |
|             | 3 "      | 239      | 4       | 8       |
|             | 4 "      | 186      | 2       | 5       |
|             | 5 "      | 18       | 1       | 2       |
|             | 6 "      | 1        | 1       | 0       |

Each record is the result of three rounds of common case.



## TRIAL OF FUZES.

December 22, 1864.

Trial of time fuzes. The time was taken with three stop clocks; the fuzes were fixed in shrapnel shell.

Elevation, 3°. Fuze bored to 0.5 of an inch.

| Stop Clock. | 1st Round. | 2nd Round. | 3rd Round. | 4th Round. | 5th Round. |
|-------------|------------|------------|------------|------------|------------|
| No. 1       | sec. 2.5   | sec. 2.1   | sec. 2.5   | sec. —     | sec. 2.1   |
| " 2         | 2.1        | —          | 2.3        | 2.4        | 2.1        |
| " 3         | 2.2        | —          | 2.6        | 2.2        | 2.1        |

February 20, 1865.

Elevation, 4°. Fuze set to 0.5 inch.

| Stop Clock. | 1st Round. | 2nd Round. | 3rd Round. | 4th Round. | 5th Round. |
|-------------|------------|------------|------------|------------|------------|
| No. 1       | sec. —     | sec. —     | sec. —     | sec. 2.1   | sec. 2.1   |
| " 2         | 1.7        | 2.2        | 2.4        | 2.4        | 2.4        |
| " 3         | 2.3        | 2.2        | —          | 2.2        | 2.4        |

Elevation, 5°. Fuze set to 1.2 inch.

| Stop Clock. | 1st Round. | 2nd Round. | 3rd Round. | 4th Round. | 5th Round. |
|-------------|------------|------------|------------|------------|------------|
| No. 1       | sec. —     | sec. 5.3   | sec. 5.5   | sec. 5.6   | sec. 5.3   |
| " 2         | Blind.     | 5.3        | 5.6        | —          | 5.4        |
| " 3         |            | 5.7        | —          | —          | 5.4        |

Time fuze set to 1.0 inch.

| Stop Clock. | 1st Round. | 2nd Round. | 3rd Round. | 4th Round. | 5th Round. |
|-------------|------------|------------|------------|------------|------------|
| No. 1       | sec. 4.3   | sec. 4.7   | sec. 4.1   | sec. 4.7   | sec. 4.5   |
| " 2         | 4.2        | 4.6        | 4.1        | 4.6        | 4.4        |
| " 3         | 4.2        | 4.6        | 4.1        | 4.5        | 4.6        |

## FUZES.

December 21, 1864.

The following experiment was carried on to ascertain whether the common wood fuze could be used with the muzzle-loading guns. 70-pounders; shrapnel shell; charge, 10 lbs.

*Ordinary Lubricator.*

|           |                  |          |
|-----------|------------------|----------|
| 1st round | - M.L. Armstrong | - Burst. |
| "         | - Whitworth      | - Blind. |
| 2nd round | - M.L. Armstrong | - "      |
| "         | - Whitworth      | - "      |
| 3rd round | - M.L. Armstrong | - "      |
| "         | - Whitworth      | - Burst. |
| 4th round | - M.L. Armstrong | - Blind. |
| "         | - Whitworth      | - Burst. |
| 5th round | - M.L. Armstrong | - "      |
| "         | - Whitworth      | - Blind. |
| 6th round | - M.L. Armstrong | - "      |
| "         | - Whitworth      | - "      |
| 7th round | - M.L. Armstrong | - "      |
| "         | - Whitworth      | - "      |

*Without Lubricator.*

|           |                  |                 |
|-----------|------------------|-----------------|
| 1st round | - M.L. Armstrong | - Burst.        |
| "         | - Whitworth      | - "             |
| 2nd round | - M.L. Armstrong | - Burst in gun. |
| "         | - Whitworth      | - Burst.        |
| 3rd round | - M.L. Armstrong | - "             |
| "         | - Whitworth      | - "             |
| 4th round | - M.L. Armstrong | - "             |
| "         | - Whitworth      | - "             |
| 5th round | - M.L. Armstrong | - "             |
| "         | - Whitworth      | - Blind.        |

The following experiment was carried on to ascertain whether the Boxer fuze supplied for Whitworth guns would be extinguished by the shell striking the water.

The fuze was bored to 1 inch, and the gun laid point blank:—

|           |                          |
|-----------|--------------------------|
| 1st round | - Burst after 1st graze. |
| 2nd "     | - " 2nd "                |
| 3rd "     | - " 1st "                |
| 4th "     | - " 1st "                |

Fuze cut to  $1\frac{1}{2}$  inches:—  
1st round - Blind.

ROUGH USAGE.

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*June 22, 1865.*

To ascertain the effect of shot striking the gun, it was laid on skidding, and fired at with a 40-pr. Armstrong breech-loading gun at a range of 40 yards, with solid cast-iron shot.

*1st Round.*

The gun was laid with its muzzle pointing towards the 40-pr. at an angle of about  $20^{\circ}$  with the line of fire.

Struck 38 inches from the muzzle, on the edge of the front hoop; made an indentation.

A shot was rammed home.

*2nd Round.*

The gun was laid with its muzzle pointing towards the 40-pr. at an angle of about  $35^{\circ}$  with the line of fire.

Struck nearly on the same spot as last; made an indentation.

A shot was rammed home.

*3rd Round.*

The gun was laid with its muzzle pointing towards the 40-pr. at an angle of about  $85^{\circ}$  with the line of fire.

Struck on the hoop in front of the trunnion and started the hoop.

Both bore and barrel were uninjured.

*4th Round.*

The gun laid exactly in the same position as for the last round.

Hit full on the chase at 29 inches from the muzzle; the inside of the bore was bulged, so that a shot could not be rammed home.

The gun was not cracked, but it was unserviceable.

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Thirty shot were thrown into a wagon and out again in a heap; this was twice repeated. The shot were subsequently fired without difficulty.



## SEA SERVICE TRIALS.

## EASE OF WORKING AS A BROADSIDE GUN.

The gun was mounted on a common truck carriage, having depression chock, bed, and elevating screw, and worked by a crew of 15 men.

The peculiarities appertaining to its fittings and stores, as differing from the land service, are as follows:—

Fair leader, with roller for trigger line, but no half-cock cleat; a wooden one was improvised.

*Gun gear.*—Eight-inch breeching (rove through carriage brackets and hitched in the first place to allow a recoil of about six feet).

A 9-inch breeching was rove on the third day of the practice.

The Whitworth cartridges not having arrived on the first day of the competitive trial on board the "Excellent," the practice was not commenced with this gun until November 1st, 1864.

The peculiarities in the fittings and stores, as differing from the sea service, were—

*The vent.*—The vent is placed in the rear of the gun; it is contained in an iron cylinder bouched with copper, the former being screwed into the gun, having recesses round its surface to contain wax for lubrication to enable the cylinder to be removed without difficulty.

The copper bouche is screwed into the iron cylinder and terminates in a cylinder of platinum, which has a hemispherical end projecting into the rear of the gun.

The vent is bored through the copper bouch and is .22 inch in diameter until it arrives at the platinum, where it is reduced to .1.

On the evening of October 31, 1864, Mr. Whitworth deemed it necessary, and was allowed to recess the outer part of his rear vent.

*The vent cover.*—A cylinder vent cover of iron, to catch the tubes at the neck ring, travelled to and fro, working by a handle, for the purpose of getting at the vent to prime or serve it.

Copper tubes (land service) were used with this gun.

*The sponge.*—Thrummed head and cylindrical brush, both separately revolving; the bristles are placed as the twist of the grooves.

*Extractor.*—Three tumbler prongs at the end of a staff adaptable to the head of projectile, and made to close thereon by a screw plate acting upon the tumbler ends.

November 1, 1864.

## INDEPENDENT FIRING.

Solid shot, 71 lbs.

Charge, 10 lbs.

Distance of target, 2,600 yards.

Size of target, 14 feet square.

Elevation, 5°.

Deflection, 0.

Wind  ; force, 3 to 4.

The intervals of time between the successive rounds were as follows:—

The Nos. awarded for accuracy are in italics.

Rounds from 1 to 12 in regular succession.

| —     | Nos. | —     | Nos. | —     | Nos. |
|-------|------|-------|------|-------|------|
| m. s. |      | m. s. |      | m. s. |      |
| 0 00  | 4    | 0 50  | 4    | 0 49  | 6    |
| 1 22  | 5    | 0 51  | 6    | 0 35  | 6    |
| 1 8   | 5    | 0 41  | 4    | 0 39  | 5    |
| 5 40  | 5    | 0 34  | 5    | 0 36  | 0    |

After the 3rd round, two strands having gone in the nip of the clinch, the breeching was shifted, delaying the gun 3 minutes 45 seconds.

At the 5th round, a delay of 5 seconds occurred from a miss-fire, occasioned by the trigger becoming unhooked.

Deducting these times, the 12 rounds were fired in 9 minutes 55 seconds.

(Average time between each of the rounds, 54.1 seconds.)

November 2, 1864.

Twenty rounds were fired under the same circumstances as yesterday, except that 5° 20' elevation was used instead of 5°, and a new 9-inch breeching had been rove, hitched to allow 6 feet recoil.

Wind  ; force, 3.

## Rounds from 12 to 32.

| —     | Nos. | —     | Nos. | —     | Nos. | —     | Nos. |
|-------|------|-------|------|-------|------|-------|------|
| m. s. |      | m. s. |      | m. s. |      | m. s. |      |
| 0 00  | 0    | 0 45  | 0    | 0 38  | 0    | 0 48  | 0    |
| 0 46  | 0    | 0 40  | 0    | 0 54  | 5    | 0 37  | 4    |
| 0 49  | 5    | 0 47  | 5    | 0 50  | 0    | 0 48  | 5    |
| 0 41  | 4    | 0 43  | 4    | 0 44  | 0    | 0 45  | 4    |
| 0 44  | 0    | 0 43  | 5    | 0 43  | 0    | 0 50  | 5    |

Completed in 14 minutes 15 seconds.

(Average time between each of the rounds, 45 seconds.)

Burnt priming at the 3rd round.

The gun hung fire at the 12th and 14th rounds.

At the 7th round the cylinder cover for vent began to work stiffly, and at the 10th round it jammed hard, and was subsequently left open altogether.

After the 12th round, 3 and 5 and 4 and 6 changed places.

At the conclusion of this firing the breeching had stretched and the hitches were closed up, allowing the gun to come in 7 feet 6 inches.

November 3, 1864.

Before commencing practice on this day, the vent was again removed and the contracted portion reamed out to .15 inch.

The breeching was hitched to allow 6 feet recoil.

The cartridges used were those obtained from Woolwich; the previous firing had been carried out with those altered at Portsmouth.

Wind  ; force, 2 to 3.

Twenty rounds were fired with the following intervals:—

## Rounds from 70 to 90.

| —     | Nos. | —     | Nos. | —     | Nos. | —     | Nos. |
|-------|------|-------|------|-------|------|-------|------|
| m. s. |      | m. s. |      | m. s. |      | m. s. |      |
| 0 00  | 5    | 0 42  | 0    | 0 40  | 0    | 0 57  |      |
| 0 44  | 5    | 0 54  | 5    | 0 59  | 6    | 2 25  |      |
| 0 41  | 6    | 0 40  | 0    | 0 31  | 6    | 0 46  | 6    |
| 0 30  | 5    | 0 35  | 0    | 0 51  | 5    | 0 38  | 4    |
| 0 29  | 5    | 0 35  | 0    | 0 54  | 6    | 0 31  | 0    |

At the 11th round the tangent sight slipped down, delaying the gun 14 seconds.

Deducting this time, the 20 rounds were fired in 14 minutes 48 seconds.

EASE OF WORKING—*continued.*

(The average time between each of the rounds being 41·5 seconds.)

“Burnt priming” at the 16th round.

The captain of the gun used the vent bit whilst loading for the 17th round.

“Burnt priming” (twice) at the 17th round.

Used vent bit, then “burnt priming” again.

After a considerable pause, the charge ignited while the captain of the gun was clearing the vent.

The breeching had now stretched out, allowing the gun 7 feet recoil.

November 2, 1864.

## QUICK FIRING.

Eighty rounds were fired with, shot, 71 lbs., charge, 10 lbs., at an elevation of 5° on account of the danger of ricochet in Portsmouth Harbour.

The direction had also to be got on for the same reason.

Nine-inch breeching; allowing 7 feet 6 inches recoil at the commencement.

The vent cover was left open altogether.

The first 20 rounds were fired with the following intervals between the successive rounds:—

These 20 rounds were from the 32nd to the 52nd in the regular succession of firing.

| m. | s. | m. | s. | m. | s. | m. | s. |
|----|----|----|----|----|----|----|----|
| 0  | 00 | 0  | 30 | 0  | 35 | 0  | 30 |
| 0  | 30 | 0  | 30 | 0  | 30 | 1  | 6  |
| 0  | 30 | 0  | 40 | 0  | 45 | 1  | 4  |
| *0 | 45 | 0  | 30 | 0  | 45 | 0  | 40 |
| 0  | 30 | 0  | 35 | 0  | 30 | 0  | 35 |

At the 3rd round, the trigger line carried away.

Shifting it and a “miss-fire” at the 4th round delayed the gun 10 seconds.

Deducting this time, the 20 rounds were fired in 11 minutes 50 seconds.

(Average time between each of the rounds, 37·3 seconds.)

After the 12th round, 3 and 5, and 4 and 6 changed places.

The low-gauge sponge was used by mistake for several rounds.

Pointing was seldom resorted to, as the gun was run out in the right direction.

At the conclusion of the firing, the breeching had stretched, and the hitches were closed up, allowing the gun to come in 8 feet 6 inches.

Eighteen rounds were then fired with the following intervals:—

Rounds from 52 to 70.

| m. | s. | m. | s. | m. | s. | m. | s. |
|----|----|----|----|----|----|----|----|
| 0  | 00 | 0  | 30 | 0  | 22 | 0  | 34 |
| 0  | 25 | 1  | 5  | 0  | 28 | 0  | 51 |
| 0  | 32 | 0  | 35 | 0  | 51 | 0  | 47 |
| 0  | 28 | 0  | 27 | 0  | 31 |    |    |
| 1  | 5  | 1  | 3  | 0  | 28 |    |    |

“Burnt priming” at the 4th (twice), 9th, 12th, 17th, and 18th rounds.

The gun hung fire at the 15th round.

The hook of left side tackle carried away at the 6th round, delaying the gun 14 seconds.

Deducting this time, the 18 rounds were fired in 9 minutes 48 seconds.

(Average time between each of the rounds, 34·6 seconds.)

The loading numbers were not changed as before.

In attempting to fire a 19th round, “burnt priming” three times; endeavoured to clear the passage with “vent bit,” then “burnt priming” again three times. This happened about 1.20 p.m., the gun being temporarily disabled, and it being necessary to take out the vent.

The shot was drawn readily by the extractor.

The hexagonal top of lubricator was then drawn out by the worm, and afterwards the cartridge was removed by the extractor.

The vent was taken out of the gun by Mr. Whitworth's foreman, and on examination the contracted part was found to be clogged with deposit from the gas.

The vent was cleared, cleansed, and replaced by half-past 3 p.m., but no further practice took place on this day, the range being foul.

November 3, 1864.

Twenty rounds were fired under the same circumstances as yesterday, except that the vent had been reamed out to 15 inch.

Breeching allowed 7 feet recoil.

Wind  ; force, 2 to 3.

Twenty rounds were fired with the following intervals:—

Rounds from 90 to 112.

| m. | s. | m. | s. | m. | s. | m. | s. |
|----|----|----|----|----|----|----|----|
| 0  | 0  | 0  | 34 | 0  | 27 | 0  | 35 |
| 0  | 30 | 0  | 30 | 0  | 49 | 0  | 35 |
| 0  | 47 | 0  | 33 | 0  | 30 | 0  | 40 |
| 0  | 33 | 0  | 31 | 0  | 32 | 0  | 40 |
| 0  | 36 | 0  | 30 | 0  | 28 | 0  | 32 |

At the 11th round split the right rear truck, a delay of 10 seconds in shifting ditto.

Deducting this time, the 20 rounds were fired in 10 minutes 42 seconds.

(The average time between each of the rounds, 33·8 seconds.)

Two rounds were then fired from this gun to make up the number to the same as that fired from the shunt and from the wedge guns.

“Burnt priming” (twice) at the 1st round: cleared with the vent bit.

## WITHOUT LUBRICATORS.

Twenty rounds were then fired.

Rounds from 112 to 132.

| m. | s. | m. | s. | m. | s. | m. | s. |
|----|----|----|----|----|----|----|----|
| 0  | 0  | 0  | 35 | 1  | 58 | 0  | 30 |
| 0  | 50 | 1  | 10 | 1  | 0  | 0  | 31 |
| 0  | 34 | 0  | 25 | 0  | 25 | 0  | 39 |
| 0  | 22 | 0  | 40 | 0  | 35 | 0  | 26 |
| 0  | 39 | 0  | 27 | 0  | 30 | 0  | 40 |

In 12 minutes 56 seconds.

(Average time between each of the rounds, 40·8 seconds.)

No difficulty was experienced in loading.

Very little pointing was required.

“Burnt priming” at the 7th, 11th (twice), and 12th rounds; the vent bit was used for clearing on each occasion. During the last eight rounds, the captain of the gun pricked the charge after every three rounds, whilst running out.

The recoil was noticed as more violent on this day than previously. The gun ran out some distance by the reaction from “taut breeching.”

After this practice it was noticed that the sponge head had worn away, exposing an iron nail that secured the thrumming.

The vent had evidently been struck constantly by this hard metal, and on examination after removing the vent, its platinum face was found to be slightly hammered, and the orifice closed to 1 inch in diameter.

The vent was also clogged with fouling, and a slight burr was apparent about the joint of the hard and soft metals.

The solid breech of the gun had been unscrewed about 3 of an inch by the previous firing.

In cleaning the gun a mass of deposit was drawn out, which had collected on and around the vent; it appeared to be composed of fragments of the cartridge accumulating after each discharge.



## EASE OF WORKING. (PIVOTING SLIDE CARRIAGE.)

November 7, 1864.

FIRING AT SPITHEAD EN RICOCLET,  
EMPTY SHELL.

Ten rounds were fired en ricochet, the gun being laid for the horizon with  $1^{\circ}$  elevation.

Empty shell, (common)  $67\frac{1}{2}$  lbs.

Charge, 10 lbs.

Length of shell,  $17\cdot95$  inches.

The deviation after first graze is recorded below, and the time of flight between first and second grazes shows approximately the height to which the projectiles rose after striking the water, thus exhibiting the uncertainty of hitting the enemy en ricochet.

| Rounds. | Deviation after 1st Graze. | Time of Flight between 1st and 2nd Grazes. | Rounds. | Deviation after 1st Graze. | Time of Flight between 1st and 2nd Grazes. |
|---------|----------------------------|--------------------------------------------|---------|----------------------------|--------------------------------------------|
|         | °                          | "                                          |         | °                          | "                                          |
| 1       | 13                         | 9                                          | 6       | $31\frac{1}{2}$            | $3\frac{1}{4}$                             |
| 2       | $1\frac{1}{2}$             | 14                                         | 7       | 14                         | $11\frac{3}{4}$                            |
| 3       | 10                         | 17                                         | 8       | 2                          | $3\frac{1}{2}$                             |
| 4       | 7                          | $11\frac{1}{2}$                            | 9       | $0\frac{1}{2}$             | $0\frac{1}{2}$                             |
| 5       | 1                          | 1                                          | 10      | $8\frac{1}{2}$             | $11\frac{3}{4}$                            |

## SHELL WITH PERCUSSION FUZES.

Ten rounds were then fired with common shell (filled), and percussion fuzes, the circumstances being the same as above. The failure of the fuzes is also recorded here.

| Rounds. | Deviation after 1st Graze.          | Time of Flight between 1st and 2nd Grazes. | Rounds. | Deviation after 1st Graze. | Time of Flight between 1st and 2nd Grazes. |
|---------|-------------------------------------|--------------------------------------------|---------|----------------------------|--------------------------------------------|
|         | °                                   | "                                          |         | °                          | "                                          |
| 1       | Burst at 1st graze.                 |                                            | 5       | Burst after 1st graze.     |                                            |
| 2       | 3   $4\frac{3}{4}$                  |                                            | 6       | Burst at 1st graze.        |                                            |
|         | (Burst, 2nd graze).                 |                                            | 7       | Burst at 1st graze.        |                                            |
| 3       | $1\frac{1}{2}$   $1\frac{3}{4}$     |                                            | 8       | Burst at 1st graze.        |                                            |
|         | (Burst in the air after 2nd graze). |                                            | 9       | 8   12                     |                                            |
| 4       | $7\frac{1}{2}$   $9\frac{1}{2}$     |                                            | 10      | Burst after 1st graze.     |                                            |

Five rounds with shot, fired under the same circumstances.

Shot, 71 lbs.

Length of ditto,  $15\cdot14$  inches.

Charge, 10 lbs.

| Rounds. | Deviation after 1st Graze. | Time of Flight between 1st and 2nd Grazes. |
|---------|----------------------------|--------------------------------------------|
|         | °                          | "                                          |
| 1       | $4\frac{1}{2}$             | $6\frac{1}{2}$                             |
| 2       | 2                          | $1\frac{3}{4}$                             |
| 3       | 6                          | $6\frac{1}{2}$                             |
| 4       | 3                          | $3\frac{1}{2}$                             |
| 5       | $2\frac{1}{2}$             | 3                                          |

The number and distance of the rebounds varied very much during the practice. Sometimes there was no second rebound, and at others several grazes were seen to strike at short distances apart.

## REMARKS.

The practice was very good for the elevation allowed; the shot were, however, falling short of the distance that was intended in the first place.

*Recoil*.—Moderate. The breeching was hitched to allow the gun to come in about 6 feet. After the 3rd round, two strands having gone in the nip of the clinch, the breeching was shifted. No undue strain was afterwards brought upon the breeching, which should have been 9-inch rope for a gun of this weight.

A 9-inch breeching was rove on the third day.

*Sponging* with the bristle sponge was heavy.

*Loading*.—3 and 4 rammed home with their feet bearing against the sweep piece; but the shot went home hand over hand, and without any check. Some little time was gained in each round at the first by not pricking the cartridge at this gun.

*Running out* was performed with great facility, on the first day especially, owing very much to the ship having  $\frac{3}{4}$  list towards the object; but it was not equal to the wedge gun in this respect, which had the five loading numbers less to man the side tackles, and not so far to travel.

The latter is also much lighter than the Whitworth gun.

*Pointing*, with one handspike, and without the aid of side tackles, was a little heavier work than with the shunt gun, in about the proportion of the respective weights.

The rear vent was choked at the 70th round. It was removed three times; on the first occasion to be cleared, on the second for the inspection of the Committee, and on the third for examination at the conclusion of the broadside practice.

On the first and last occasions it was found to have closed near its platinum end.

The extractor answered its purpose very well.

ABSTRACT from the REPORT of the SEA SERVICE TRIALS.

The Time was taken from the firing of the first Round to the firing of the last Round in each Series, striking the Average at the Conclusion by dividing by the Number of Rounds less One. Deductions only were made where delays occurred from mishaps totally unconnected with the System or Construction of the Guns. The Numbers for Accuracy are awarded according to the Method usually adopted in "EXCELLENT," from 0 to 3 for ELEVATION, from 0 to 3 for DIRECTION.

|                                                                                                                                                                        |            | WHITWORTH.                                 |       |                                                                                                                                   |                                                                                                                                                                                |          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 70-pounder gun, mounted on the lower deck of "Excellent."                                                                                                              |            | Rounds.                                    | Time. | Average Time each Round.                                                                                                          | Numbers awarded for Accuracy.                                                                                                                                                  | Remarks. |
| Independent firing, 2,600 yards.                                                                                                                                       | 20 Nov. 2  | m. s.                                      | sec.  | 46                                                                                                                                | After 3rd round shifted breeching.<br>From the 19th round the cylinder cover for vent was not used.<br>Burnt priming at the 36th round.                                        |          |
|                                                                                                                                                                        | 20 Nov. 3  | 14 48                                      | 41.5  | 69                                                                                                                                |                                                                                                                                                                                |          |
|                                                                                                                                                                        | 12 Nov. 1  | 9 55                                       | 54.1  | 55                                                                                                                                |                                                                                                                                                                                |          |
|                                                                                                                                                                        | Total Nos. | —                                          | —     | —                                                                                                                                 |                                                                                                                                                                                | 170      |
| Directional quick firing. Elevation, 5° to 6°.                                                                                                                         |            | 20                                         | 11 50 | 37.3                                                                                                                              | From the 57th round "burnt priming" frequently took place until the 70th round; the gun was temporarily disabled by the closing of the vent-hole.                              |          |
| November 2, 1864.                                                                                                                                                      |            | 18                                         | 9 48  | 36.4                                                                                                                              | Vent removed, cleared, and cleansed in about two hours, but no further firing took place on that day.                                                                          |          |
| November 2, 1864. New 9-inch breeching.                                                                                                                                |            | 20                                         | 10 42 | 33.8                                                                                                                              | The next morning the vent was again removed and reamed out to .15 inch.                                                                                                        |          |
| November 3, 1864. Without lubricators                                                                                                                                  |            | 20                                         | 12 56 | 40.8                                                                                                                              | "Burnt priming" again commenced at the 86th round, but henceforth the vent was kept clear by using the wire.                                                                   |          |
| Totals                                                                                                                                                                 |            | 130                                        | 86 9  | 43.3                                                                                                                              | After 134 rounds vent was again removed, and the orifice found to be closed to 1 in.<br>Metal attached to the sponge head had struck the vent during the last 30 or 40 rounds. |          |
| 8-inch gun on the lower deck of "Excellent."<br>Independent firing, 1,800 yards.<br>November 1, 1864.<br>Directional quick firing. Elevation, 5°.<br>November 1, 1864. | 1 Nov. 3   | With 3 rifled spheres.<br>1° elevation.    |       | One sphere broken, the other two ranged apart, and distant about 600 yards.                                                       |                                                                                                                                                                                |          |
|                                                                                                                                                                        | 1 Nov. 3   | With 1 rifled sphere.<br>1° 35' elevation. |       | Ranged 1,000 yards, and ricocheted in a straight course.<br>A mass of deposit drawn out from around the vent on cleaning the gun. |                                                                                                                                                                                |          |

|                                                                                       |  | Rounds. | No. Burst.                 | Average dist. of Explosion from Ship's side. | Pre-mature.                            | Blind. | Remarks.                                          |
|---------------------------------------------------------------------------------------|--|---------|----------------------------|----------------------------------------------|----------------------------------------|--------|---------------------------------------------------|
| Shell and percussion fuzes against "Alfred," 700 yards. November 4, 1864. Hit direct. |  | 12      | 10                         | About 14 feet                                | 0                                      | 0      | 2 missed ship and burst, 1st graze.               |
| November 14 and 15, 1864.                                                             |  | 18 7    | 17 5                       | Do. 15 to 20 feet.                           | 0 0                                    | 1 2    | Long shell; hole in off side, 3 ft. x 2 ft. 6 in. |
| Hit en ricochet                                                                       |  | 1 12    | 1 5                        | In outer planking. Not ascertained.          | 0 6 1st graze.                         | 0 0    | 1 missed ship, did not burst.                     |
| Ricochet Practice.                                                                    |  | Rounds. | Average.                   |                                              | Failure of Fuzes.                      |        | Remarks.                                          |
| 1° Elevation.                                                                         |  |         | Deviation after 1st Graze. | Time of Flight between 1st and 2nd Grazes.   |                                        |        |                                                   |
| November 7, 1864.                                                                     |  |         |                            |                                              |                                        |        |                                                   |
| Empty shell                                                                           |  | 10      | 6°                         | 8 1/4"                                       | { 6burst, 1st graze<br>2 do. 2nd graze |        |                                                   |
| Shell and percussion fuzes                                                            |  | 10      | 5°                         | 7 1/2"                                       |                                        |        |                                                   |
| Shot                                                                                  |  | 5       | 3 1/4°                     | 5 1/4"                                       |                                        |        |                                                   |
| Total                                                                                 |  | 25      | 5° Mean                    | 7"                                           |                                        |        |                                                   |

SEA SERVICE TRIALS—*continued.*En ricochet.—*November 14 and 15, 1864.*

| Rounds. | Struck Water short of the Ship. | Whitworth.                                                          |
|---------|---------------------------------|---------------------------------------------------------------------|
| 1       | Yards. 90                       | Burst (in-board).                                                   |
| 2       | —                               | Burst (after 1st graze, and 40 yards beyond it).                    |
| 3       | 10                              | Burst (in-board).                                                   |
| 4       | —                               | Burst (after 1st graze, and 40 yards beyond it).                    |
| 5       | 20                              | Burst (in-board).                                                   |
| 6       | 60                              | Ricocheted over ship.                                               |
| 7       | 6                               | Burst (just after 1st graze, pieces did not penetrate ship's side). |
| 8       | 100                             | Burst (in-board.)                                                   |
| 9       | 30                              | Burst (after 1st graze).                                            |
| 10      | 60                              | Burst (after 1st graze).                                            |
| 11      | 15                              | Burst (in-board).                                                   |
| 12      | 90                              | Burst (10 yards after 1st graze).                                   |
| 13      |                                 |                                                                     |
| 14      |                                 |                                                                     |
| 15      |                                 |                                                                     |
| 16      |                                 |                                                                     |

## PRACTICE with the WHITWORTH SHELL (Long) of 4 Diameters.

|                             |         |            |           |                 |
|-----------------------------|---------|------------|-----------|-----------------|
| Target "Alfred," 750 yards. | Weight  | - 64½ lbs. | Length    | - 20½ inches.   |
|                             | Burster | - 5 "      |           | 1 inch (sides). |
|                             | Total   | - 69½ "    | Thickness | 1 inch (base).  |

*November 15, 1864.*

| —                 | Rounds. | Remarks.                                                                                                                                                             |
|-------------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hit direct - -    | 1       | Burst (on the opposite side of lower deck after tearing fore bitts).                                                                                                 |
|                   | 2       | No burst (struck the near gunwale in a part much weakened by previous firing, resistance apparently insufficient for the fuze to act).                               |
|                   | 3       | Burst (close down on main deck, fracturing beam (in twain) and carline below, destroying the planks).                                                                |
|                   | 4       | Through both sides, and burst on striking the water 400 yards beyond.                                                                                                |
|                   | 5       | Burst } 1 burst 10 feet in, after passing through shelf piece on main deck, and destroyed a beam end.                                                                |
|                   | 6       | Burst } 1 burst in a square of fore hatchway, tearing away its larger portion.                                                                                       |
|                   | 7       | Burst } 1 burst 20 feet in, blowing up carlines and upper-deck planks.                                                                                               |
| Hit en ricochet - | 1       | Burst in the outer planking after striking water five yards short of ship.                                                                                           |
|                   |         | After the trials were over, Mr. Forrest, of the R.L.D., was sent by Col. Boxer* to say that the fuzes used for Whitworth shell were not those intended for ricochet. |

\* The Committee inquired into this matter and ascertained that the fuze which Colonel Boxer stated should have been used on this occasion was not referred to in any of the lists or drawings of ammunition forwarded to them, although it appears that it had been forwarded to Shoeburyness without their knowledge.

SEA SERVICE TRIALS—*continued.*

PRACTICE with COMMON SHELL and PERCUSSION FUZES, from the 70-pounder WHITWORTH GUN, mounted (on Naval Slide Carriage) on board the Gunboat "STORK," in PORTSMOUTH HARBOUR. Target, "ALFRED," wooden Frigate, distant 700 yards.

|                      |   |             |   |   |   |
|----------------------|---|-------------|---|---|---|
| Thickness of side at | { | Upper Works | - | 1 | 5 |
|                      |   | Main deck   | - | 2 | 0 |
|                      |   | Bends       | - | 2 | 5 |

Ft. in.

Oak timbers and planking. The main-deck ports were filled in with fir to the thickness of ship's side.

Hit Direct—November 4, 1864.

## Percussion Fuze (special Gauge).

Elevation 1° 23'.

|         |   |   |          |
|---------|---|---|----------|
| Shell   | - | - | 67½ lbs. |
| Burster | - | - | 2½ "     |
|         |   |   | 70 "     |

Length, 17·95 inches.

Thickness { 1·5 (sides).  
1·0 (base).

12 rounds were fired from each gun with the following results:—

1. Struck water 450 yards beyond, and burst.
2. Burst (14 feet in-board).
3. Burst (on opposite side of fore-castle).
4. Burst.
5. Burst.
6. Burst (on striking chain slings).
7. Burst.
8. Burst.
9. Burst.
10. Burst.
11. 455 yards beyond, and burst on striking water.
12. Burst.

Spread of explosion about 20°; very slight damage and splintering.

November 14 and 15.

13. Burst.
14. Burst (opposite side).
15. Burst do.
16. Burst do.
17. Burst do.
18. Burst.
19. Burst.
20. Burst.
21. No burst (through, 600 yards beyond, and one rebound).
22. Burst.
23. Burst.
24. Burst.
25. Burst (in the opposite side, driving out large splinters).
26. Burst (intended for ricochet).
27. Burst do.
28. Burst do.
29. Burst do.
30. Burst do., exploded in opposite side, opening a hole in each about 3 feet by 2 feet 6 inches.



# 70-PR. WHITWORTH SHELL.

H.M.S. "EXCELLENT," December 13, 1864.

PRACTICE WITH COMMON SHELL AND PERCUSSION FUZES FROM THE 70-PR. WHITWORTH GUN, MOUNTED ON BOARD THE "STORK" GUN BOAT, IN CONTINUATION OF THE TRIALS MADE FOR THE ARMSTRONG AND WHITWORTH COMMITTEE IN NOVEMBER LAST.

TARGET, "ALFRED" (WOODEN FRIGATE). Distance, 700 Yards. Charge, 10 lbs.

|                 |   |   |   |          |
|-----------------|---|---|---|----------|
| Weight of Shell | - | - | - | 67½ lbs. |
| Burster         | - | - | - | 2½ "     |
| Total           | - | - | - | - 70 "   |

FUZES, METAL, MARKED P., THE WRAPPERS IN WHICH THEY WERE PACKED BEING MARKED PERCUSSION.

| Hit Direct. |                                                  |         |                                                                    | Hit en Ricochet.                                                                                                                                                                    |                   |                   |                   |
|-------------|--------------------------------------------------|---------|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------|-------------------|
| Rounds.     | Remarks.                                         | Rounds. | Remarks.                                                           | Rounds.                                                                                                                                                                             | Struck the Water. | Remarks.          | Remarks.          |
| 1           | Burst.                                           | 17      | Burst.                                                             | 1                                                                                                                                                                                   | 100 yds. short    | Burst, 1st graze. | Burst, 1st graze. |
| 2           | Burst.                                           | 18      | Uncertain, probably passed through ship. No burst.                 | 2                                                                                                                                                                                   | 70 "              | Burst, 1st graze. | Burst, 1st graze. |
| 3           | Burst.                                           | 19      | Passed through, burst 2nd graze.                                   | 3                                                                                                                                                                                   | 50 "              | Burst, 1st graze. | Burst in-board.   |
| 4           | Burst.                                           | 20      | Passed through, burst 2nd graze.                                   | 4                                                                                                                                                                                   | 25 "              | Burst, 1st graze. | Burst, 1st graze. |
| 5           | Burst.                                           | 21      | Passed through, 3 grazes. No burst.                                | 5                                                                                                                                                                                   | 15 "              | Burst, 1st graze. | Burst in-board.   |
| 6           | Burst.                                           | 22      | Burst.                                                             | 6                                                                                                                                                                                   | 90 "              | Burst, 1st graze. | Burst, 1st graze. |
| 7           | Burst.                                           | 23      | Burst.                                                             | 7                                                                                                                                                                                   | 90 "              | Burst at muzzle.  | Burst, 1st graze. |
| 8           | Burst.                                           | 24      | Burst.                                                             | 8                                                                                                                                                                                   | 25 "              | Burst in-board.   | Burst, 1st graze. |
| 9           | Burst.                                           | 25      | Burst.                                                             | 9                                                                                                                                                                                   | 70 "              | Burst in-board.   | Burst, 1st graze. |
| 10          | Burst.                                           | 26      | Burst.                                                             | 10                                                                                                                                                                                  | 70 "              | Burst, 1st graze. | Burst, 1st graze. |
| 11          | Missed, passing over ship, did not burst beyond. | 27      | Burst.                                                             | 11                                                                                                                                                                                  | 200 "             | Burst, 1st graze. | Burst, 1st graze. |
| 12          | Burst.                                           | 28      | Burst.                                                             |                                                                                                                                                                                     |                   |                   |                   |
| 13          | Burst.                                           | 29      | Burst.                                                             |                                                                                                                                                                                     |                   |                   |                   |
| 14          | Burst.                                           | 30      | 2 shell burst on the near side, 1 of which fractured an iron knee. |                                                                                                                                                                                     |                   |                   |                   |
| 15          | Burst.                                           | 31      |                                                                    |                                                                                                                                                                                     |                   |                   |                   |
| 16          | Burst.                                           | 32      |                                                                    |                                                                                                                                                                                     |                   |                   |                   |
|             |                                                  |         |                                                                    | After this day's practice was over Mr. Forrest, from the Royal Laboratory Department, came on board and stated that the fuzes used were again not those to be fired—"en ricochet."* |                   |                   |                   |

\* These fuzes were selected by Mr. Forrest, who previous to the experiment informed the Committee that they were intended to be used "en ricochet."

MR. WHITWORTH'S PROGRAMME.

PRACTICE WITH RIFLED SPHERES.  
On board H.M.S. "Excellent."  
November 3, 1864.

Two rounds were fired with these projectiles, their weight 22 lbs., charge 10 lbs.  
First round.—Three were entered, numbered respectively, 1, 2, 3 (outside).  
Elevation 1°; distance of target, 500 yards; size of target 8 feet square.  
First graze { 2 shot, about 600 yards.  
                  1 shot, about 200 yards.  
                  ricochetting through target.  
1 of the above broke on firing.  
One of these shot or a fragment ricocheted outside the range posts, another a long way to the right.  
Second round.—One sphere only (No. 4.)  
Elevation 1° 35'; distance of target, 1,000 yards; size of target, 8 feet square.  
First graze, 1,050 yards and 10 yards left; ricochetting onwards in apparently a straight course.

November 30, 1864.  
SHOEBURYNESS.  
RIFLED SPHERES.  
3 rifled spheres.  
8 lbs. charge.  
500 yards range.  
9 feet target, floating.

The following experiment was carried on with the Whitworth 70-pounder gun, to show its capability of throwing rifled spheres, a junk wad was rammed home after the spheres:—  
1st Round.—One sphere fell 150 yards short, the other two spheres fell about 20 yards beyond and about three yards right and left of the target.  
2nd Round.—One sphere fell in line close over the target, the other two spheres fell about 10 yards short and about six yards right and left of target. Ricochet of spheres appeared to be in good line, and ranged from 1,000 to 2,000 yards.  
3rd Round.—Three spheres fell close round the target, one hit. Ricochet in good line, about 2,000 yards.  
4th Round.—Two spheres fell about 50 yards short and in line, the other sphere fell about 150 yards short and 30 yards to the left.  
5th Round.—Two spheres fell about 20 yards short and five yards to the left, the other sphere about 10 yards beyond and 50 yards to the right.

December 6, 1864.—SHOEBURYNESS.  
The gun was mounted on a standing carriage and elevated at 33° elevation.  
Common shell, 5 diameters long.  
The gun was laid by the clinometer.

| Rounds. | Range. | Deflection, Right. | Charge. |
|---------|--------|--------------------|---------|
|         | Yards. | Yards.             |         |
| 1       | 1,203  | 29.0               | 1 lb.   |
| 2       | 1,220  | 30.4               | "       |
| 3       | 1,204  | 28.6               | "       |
| 4       | 1,238  | 30.0               | "       |
| 5       | 1,182  | 29.6               | "       |
| 6       | 1,222  | 28.8               | "       |
| 7       | 1,276  | 30.0               | "       |
| 8       | 1,349  | 31.0               | "       |
| 9       | 2,642  | 45.0               | 2 lbs.  |
| 10      | 2,689  | 49.0               | "       |
| 11      | 2,603  | 51.0               | "       |
| 12      | 2,571  | 43.0               | "       |
| 13      | 2,518  | 45.4               | "       |
| 14      | 2,587  | 45.0               | "       |
| 15      | 2,514  | 39.0               | "       |
| 16      | 2,558  | 45.8               | "       |
| 17      | 7,274  | 87.0               | 6 lbs.  |
| 18      | 7,212  | 103.0              | "       |
| 19      | 7,180  | 108.0              | "       |
| 20      | 7,054  | 91.0               | "       |

PRACTICE WITH RIFLED SPHERES.  
On board H.M.S. "Stork" at Spithead.  
November 7, 1864.

Three rounds were fired en ricochet with the rifle spheres, three being entered at a time. (Weight of each, 18 lbs.); charge, 10 lbs.; elevation, &c., as before.  
One of the spheres in each round was apparently broken on discharge; the other two ranged about the same distance with respect to each other, but apart.  
Whitworth vent.—The cartridge was pricked for every round throughout to-day's practice.  
There were no "miss-fires;" but on looking through the vent it appeared to have slightly closed up.

December, 5, 1864.—SHOEBURYNESS.  
Charge, 10 lbs.  
Single rifled sphere, fired at a 9-foot target.  
RANGE, 1,000 yards.  
1st Round, 84 yards over, 1 yard left.  
2nd " 104 " line.  
3rd " 33 inches from centre of target.  
4th " 8 yards short, in line.  
5th " 114 yards over, 1 yard right.  
6th " 68 " 0.6 "  
7th " 69 " 1.2 "  
8th " 88 " 1.0 "  
9th " 40 inches from centre of target.  
10th " 48 " " "

RANGE, 1,500 yards.  
1st Round, 16 yards over, 8 yards left.  
2nd " 162 yards short, 10 "  
3rd " 64 " 8 "  
4th " 16 yards over, 8 "  
5th " 48 " short, 5 "  
6th " 20 " line.  
7th " 90 " 1 yard left.  
8th " 4 " 1 "  
9th " 44 " 1½ "  
10th " 100 " 2 "  
11th " 14 " over, 2 "  
12th " 50 " 0.5 "  
13th " 44 " short, 2 "  
14th " 4 " 2 yards right.  
15th " 6 " over, 4 "  
16th " 8 " short, 3 yards left.  
17th " 50 " over, 6 "  
18th " 38 " 3 "  
19th " 69 " short, 1 "  
20th " not seen.

WHITWORTH 70-POUNDER PROGRAMME.  
November 24, 1864.—SHOEBURYNESS.  
The gun was mounted on a standing carriage, with the trucks taken off. The front of the carriage raised by skidding, so as to elevate the gun to angle of 33°.

| Rounds. | Range.   | Charge. | Projectile. | Deflection, Right. |
|---------|----------|---------|-------------|--------------------|
|         | Yards.   |         |             | Yards.             |
| 1       | 8,480    | 10 lbs. | Shot        | 55                 |
| 2       | 9,350    | "       | "           | 220                |
| 3       | 9,500    | "       | "           | 180                |
| 4       | 9,500    | "       | "           | 200                |
| 5       | 9,420    | "       | "           | 175                |
| 6       | 9,565    | 12 lbs. | "           | 170                |
| 7       | 9,520    | "       | "           | 164                |
| 8       | 9,545    | "       | "           | 160                |
| 9       | 9,540    | "       | "           | 156                |
| 10      | 9,486    | "       | "           | 173                |
| 11      | Not seen | 10 lbs. | Hollow shot | —                  |
| 12      | "        | "       | "           | —                  |
| 13      | 9,410    | "       | "           | 130                |
| 14      | 9,535    | "       | "           | 160                |
| 15      | 9,500    | "       | "           | 145                |
| 16      | 9,634    | 12 lbs. | "           | 107                |
| 17      | 9,590    | "       | "           | 120                |
| 18      | 9,576    | "       | "           | 86                 |
| 19      | 9,570    | "       | "           | 97                 |
| 20      | 9,642    | "       | "           | 132                |

The gun was laid by Mr. Whitworth's man.  
November 24 :—Strong breeze down the range.  
" 25 :—Very light breeze.

# 70-PR. WHITWORTH SHOT. (FLAT-HEADED.)

## PENETRATION UNDER WATER.

PRACTICE from the "STORK" GUN BOAT, moored between 20 and 25 yards from the "ALFRED" frigate (oak built).

The "Alfred" was sunk so that her upper deck was almost flush with the water. Thickness of ship's side, 22 to 24 inches. The gun was depressed so as to strike the ship about two feet below the water line. A junk was placed outside the shot to prevent its shifting in the bore.

Weight. Shot - - 70 lbs. Length. 13.75 inches. Diameter at head. 4½ inches.

| Rounds. | Ship's Side.                                      |                                      |                         |                                     | Results.                                                                                                                       | Projectiles after Firing.<br>(Ship full of Water.)                                                                                                                                                                      |
|---------|---------------------------------------------------|--------------------------------------|-------------------------|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | Distance from where Projectile entered the Water. | Part struck.                         | Depth below Water Line. | Thickness.                          |                                                                                                                                |                                                                                                                                                                                                                         |
| 1       | About 10 yards                                    | Midway between upper and main decks. | ft. 3 in. 9             | 24 inches, in a diagonal direction. | Passed through ship's side.                                                                                                    | Three shots were found forward on the main deck, and one aft, at distances of from 10 to 12 feet in-board, they had evidently been spent there, as there were no signs of their having struck any of the midship parts. |
| 2       | 8 to 10 yards                                     | Between upper deck and shelf piece.  | 2 6                     | 22 inches, ditto.                   | Ditto.                                                                                                                         |                                                                                                                                                                                                                         |
| 3       | Ditto                                             | Ditto - -                            | 2 0                     | 19 inches, more direct.             | Ditto.                                                                                                                         |                                                                                                                                                                                                                         |
| 4       | Ditto                                             | Ditto - -                            | 1 7                     | 18 inches                           | Ditto.                                                                                                                         |                                                                                                                                                                                                                         |
| 5       | Ditto                                             | Just below shelf piece on main deck. | 1 4                     | Total thickness, 3 ft. 2 ins.       | Struck in the wake of a knee; as shown in tracing, shot brought up by the resistance at one foot from exterior of ship's side. | This shot could not be found in the hole, probably it fell back overboard, leaving a clean cylindrical hole of about its own size.                                                                                      |
| 6       | 10 to 12 yards                                    | Midway between upper and main decks. | 2 6                     | 22 inches                           | Passed through ship's side.                                                                                                    |                                                                                                                                                                                                                         |
| 7       | 8 to 10 yards                                     | Between upper deck and shelf piece.  | 2 0                     | 22 inches                           | Ditto.                                                                                                                         |                                                                                                                                                                                                                         |

MR. WHITWORTH'S PROGRAMME—*continued.*

SHOEBURYNNESS.

*Projectile and Ammunition.*

Nature, common shell.  
 Weight, 69 lbs., empty.  
 Diameter { major, 5.46 in.  
               minor, 4.98 in.

Length, 21 inches.  
 Bursting charge, 5 lbs.  
 Charge, 11 lbs.

| No. of Round. | Elevation.   | Range.               | 1st Graze. | Remarks.                                                                                                              |          |              |       |    |
|---------------|--------------|----------------------|------------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|               |              |                      | Right.     |                                                                                                                       |          |              |       |    |
|               | °            | Yards.               | Yards.     | November 25, 1864.                                                                                                    |          |              |       |    |
| 1             | 4            | 2,182                | 14.0       |                                                                                                                       |          |              |       |    |
| 2             | "            | 2,151                | 13.8       |                                                                                                                       |          |              |       |    |
| 3             | "            | 2,235                | 18.4       |                                                                                                                       |          |              |       |    |
| 4             | "            | 2,236                | 24.4       |                                                                                                                       |          |              |       |    |
| 5             | "            | 2,114                | 14.6       |                                                                                                                       |          |              |       |    |
| 6             | "            | 2,214                | 15.2       | Weather :—Clear.                                                                                                      |          |              |       |    |
| 7             | "            | 2,139                | 21.2       | Wind :—Direction, W.; force, 3 ; 10 a.m.                                                                              |          |              |       |    |
| 8             | "            | 2,183                | 16.0       | " S.W. " 3 ; 3 p.m.                                                                                                   |          |              |       |    |
| 9             | "            | 2,137                | 23.0       | Thermometer :—39 dry, 38 wet, 10 a.m.                                                                                 |          |              |       |    |
| 10            | "            | 2,186                | 25.2       | 43 " 40 " 3 p.m.                                                                                                      |          |              |       |    |
| 11            | "            | 2,214                | 24.6       |                                                                                                                       |          |              |       |    |
| 12            | "            | 2,194                | 22.4       |                                                                                                                       |          |              |       |    |
| 13            | "            | 2,230                | 16.0       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.40</td><td>44</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.40 | 44 |
| Reading.      | Temperature. |                      |            |                                                                                                                       |          |              |       |    |
| 29.40         | 44           |                      |            |                                                                                                                       |          |              |       |    |
| 14            | "            | 2,139                | 22.6       | <table><tr><td>29.45</td><td>46</td></tr></table> 3 p.m.                                                              | 29.45    | 46           |       |    |
| 29.45         | 46           |                      |            |                                                                                                                       |          |              |       |    |
| 15            | "            | 2,184                | 14.0       |                                                                                                                       |          |              |       |    |
| 16            | "            | 2,176                | 22.2       |                                                                                                                       |          |              |       |    |
| 17            | "            | 2,137                | 23.2       |                                                                                                                       |          |              |       |    |
| 18            | "            | 2,269                | 20.0       |                                                                                                                       |          |              |       |    |
| 19            | "            | 2,158                | 26.0       |                                                                                                                       |          |              |       |    |
| 20            | "            | Broke up in the gun. |            |                                                                                                                       |          |              |       |    |
|               |              |                      |            | December 5, 1864.                                                                                                     |          |              |       |    |
| 1             | 10           | 4,568                | 9.4        |                                                                                                                       |          |              |       |    |
| 2             | "            | 4,696                | 22.0       |                                                                                                                       |          |              |       |    |
| 3             | "            | 4,554                | 14.0       |                                                                                                                       |          |              |       |    |
| 4             | "            | 4,620                | 28.0       |                                                                                                                       |          |              |       |    |
| 5             | "            | 4,570                | 16.0       |                                                                                                                       |          |              |       |    |
| 6             | "            | 4,550                | 32.0       | Weather :—Slight haze, 10 a.m.                                                                                        |          |              |       |    |
| 7             | "            | 4,540                | 33.0       | Clear, 3 p.m.                                                                                                         |          |              |       |    |
| 8             | "            | 4,656                | 16.0       |                                                                                                                       |          |              |       |    |
| 9             | "            | 4,576                | 11.0       | Wind :—Direction, S.W. by W.; force, 5 ; 10 a.m.                                                                      |          |              |       |    |
| 10            | "            | 4,570                | 16.0       | " S.W. by S. " 3 ; 3 p.m.                                                                                             |          |              |       |    |
| 11            | "            | 4,600                | 20.0       | Thermometer :—48 dry, 46 wet, 10 a.m.                                                                                 |          |              |       |    |
| 12            | "            | 4,560                | 34.0       | 50 " 48 " 3 p.m.                                                                                                      |          |              |       |    |
| 13            | "            | 4,540                | 32.0       |                                                                                                                       |          |              |       |    |
| 14            | "            | 4,450                | 22.0       |                                                                                                                       |          |              |       |    |
| 15            | "            | 4,620                | 35.0       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.15</td><td>48</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.15 | 48 |
| Reading.      | Temperature. |                      |            |                                                                                                                       |          |              |       |    |
| 30.15         | 48           |                      |            |                                                                                                                       |          |              |       |    |
| 16            | "            | 4,624                | 24.0       | <table><tr><td>30.08</td><td>51</td></tr></table> 3 p.m.                                                              | 30.08    | 51           |       |    |
| 30.08         | 51           |                      |            |                                                                                                                       |          |              |       |    |
| 17            | "            | 4,630                | 40.0       |                                                                                                                       |          |              |       |    |
| 18            | "            | 4,640                | 22.0       |                                                                                                                       |          |              |       |    |
| 19            | "            | 4,560                | 18.0       |                                                                                                                       |          |              |       |    |
| 20            | "            | 4,580                | 32.0       |                                                                                                                       |          |              |       |    |
|               |              |                      |            | December 6, 1864.                                                                                                     |          |              |       |    |
| 1             | 7            | 3,521                | 21.2       | The gun was laid by Mr. Leece, Mr. Whitworth's representative.                                                        |          |              |       |    |
| 2             | "            | 3,517                | 21.0       |                                                                                                                       |          |              |       |    |
| 3             | "            | 3,456                | 23.4       |                                                                                                                       |          |              |       |    |
| 4             | "            | 3,393                | 31.4       |                                                                                                                       |          |              |       |    |
| 5             | "            | 3,387                | 31.2       |                                                                                                                       |          |              |       |    |
| 6             | "            | 3,244                | 21.8       | Weather :—Thick haze on water, 10 a.m.                                                                                |          |              |       |    |
| 7             | "            | 3,467                | 32.8       | Very thick haze, 3 p.m.                                                                                               |          |              |       |    |
| 8             | "            | 3,391                | 31.8       |                                                                                                                       |          |              |       |    |
| 9             | "            | 3,404                | 19.6       | Wind :—Direction, S.W. by W.; force, 2 ; 10 a.m.                                                                      |          |              |       |    |
| 10            | "            | 3,435                | 31.6       | " W.S.W. " 2 ; 3 p.m.                                                                                                 |          |              |       |    |
| 11            | "            | 3,515                | 34.4       | Thermometer :—47 dry, 46 wet, 10 a.m.                                                                                 |          |              |       |    |
| 12            | "            | 3,435                | 38.0       | 48 " 47 " 3 p.m.                                                                                                      |          |              |       |    |
| 13            | "            | 3,386                | 26.8       |                                                                                                                       |          |              |       |    |
| 14            | "            | 3,266                | 38.8       |                                                                                                                       |          |              |       |    |
| 15            | "            | 3,529                | 31.0       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.00</td><td>49</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.00 | 49 |
| Reading.      | Temperature. |                      |            |                                                                                                                       |          |              |       |    |
| 30.00         | 49           |                      |            |                                                                                                                       |          |              |       |    |
| 16            | "            | 3,300                | 29.0       | <table><tr><td>30.00</td><td>50</td></tr></table> 3 p.m.                                                              | 30.00    | 50           |       |    |
| 30.00         | 50           |                      |            |                                                                                                                       |          |              |       |    |
| 17            | "            | 3,437                | 39.2       |                                                                                                                       |          |              |       |    |
| 18            | "            | 3,444                | 30.0       |                                                                                                                       |          |              |       |    |
| 19            | "            | 3,342                | 29.0       |                                                                                                                       |          |              |       |    |
| 20            | "            | 3,388                | 30.4       |                                                                                                                       |          |              |       |    |



MR. WHITWORTH'S PROGRAMME—*continued.*

## IRON PLATES.

October 27, 1864.

Special Shell supplied by Mr. Whitworth.

Bursting charge,  $\frac{3}{4}$  lb.

RANGE, 400 yards.

Charge, 12 lbs.

1st Round.—Struck the Warrior target exactly on a hole made by a former shell (No. 2 Whitworth

at 50 yards), broke through the skin and broke the rib in rear, bent and distorted the rib to a distance of  $2\frac{1}{2}$  feet below the hole.

2nd Round.—Struck 2 ft.  $4\frac{1}{2}$  in. from the left edge of the target, buried itself its whole length and bulged the inside skin.

SHOEBURYNESSE, December 5, 1864.

Whitworth steel shells for 70-pounder gun, fired at "Warrior" target at 600 yards range.

These shells are flat-headed, 14·8 inches long, and of peculiar construction. A plug 4 inches long and 2·1 inches in diameter, is fitted tightly into the front of the shell, and the base is closed with a screw plug. A small spindle attached to this plug passes up the axis; it is hollow, and has a nipple in front, on which a percussion cap, which plays loosely in the interior, is intended to be set in action when the shell is arrested by the iron target. Several small holes at the base of the spindle allow the exit of the

flame from the cap. The bursting charge, viz., 1 lb. of powder, is placed in a bag and secured round the spindle, and ignited by the cap composition.

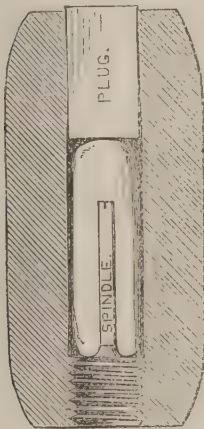
The intention of this arrangement is that the shell should act as a gun as soon as it has done its work of penetration, and so force the plug through the inner skin of the target.

Weight of shell, 74 lbs. 2 ozs. Length, 14·8".

Charge, 12 lbs. of large grain powder (L.G.)

Burster, 1 lb.

Length of plug, 4 inches. Diameter, 2·25".



1st Round, Trial flat-headed Shot, Cast Iron.

Struck the ground 11 yards short, and ricocheted on to the target sideways, making a slight dent, and breaking up.

2nd Round, Another Trial Shot of the same kind.

Struck 3 feet above the bull's-eye and about 2 feet from the top edge. Making a dent of about one inch deep, and then breaking up.

3rd Round, Steel Shell.

Struck 2 feet 8 inches from the top, 5 feet 8 inches from the left hand of plate, 2 inches below the indent caused by No 2. It entered the target and the burster was fired, the base of the shell 3·3 inches from the face of the plate. The plug was driven by the burster through the iron skin, carrying with it the portion of the plate struck and a large piece of the iron skin. No bolts were broken. The plug set up about  $\frac{1}{4}$  of an inch. This shell acted exactly as intended by Mr. Whitworth.

4th Round, Steel Shell.

Struck and left a hole 2 feet deep, at 14 inches from the top, and 3 feet 6 inches from the left-hand edge of the target, 3 inches from a securing bolt. Just in line with the edge of the timber supports, which are 20 inches square, the burster exploded; the piece of the plate and the plug of the shell were driven against the iron skin. The shell itself was driven out backwards a distance of 74 yards; the shell was set up about 1·8 inches. An iron rivet head was broken off and the skin slightly bulged.

5th Round, Steel Shell.

Struck 4 feet 6 inches from the top of target, on an old shot fired from the Whitworth 70-pounder, on June 24, 1864, at a range of 50 yards. The burster exploded and the shell broke up.

6th Round, Steel Shell.

Struck 3 feet 6 inches from the top and 5 feet 6 inches from the left edge of the target, 4 inches from the fracture caused by No. 5. The piece of the plate struck was driven against the skin. The burster exploded, driving out the plug and forcing the shell backwards a distance of 104 yards. The head was set up 2·3 inches.

The part of the target struck this round is backed by a vertical stringer.

COMMITTEE'S PROGRAMME.

LONG COMMON SHELL.

SHOEBURYNNESS.

Weight, 69 lbs., empty.

Diameter { major, 5.46 in.  
          minor, 4.98 in.

Length, 21 inches.  
Bursting charge, 5 lbs.  
Charge, 10 lbs.

The gun was fired from the rear vent.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                          |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | In Line.   | Right. | Left.  |                                                                                                                                                                   |          |              |       |    |       |    |
|               | °            | Yards. |            | Yards. | Yards. |                                                                                                                                                                   |          |              |       |    |       |    |
| 1             | 4            | 2,047  | —          | 23.6   | —      | November 23, 1864.<br>Fired from B. gun.                                                                                                                          |          |              |       |    |       |    |
| 2             | "            | 1,917  | —          | 25.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 3             | "            | 1,886  | —          | 25.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 4             | "            | 2,007  | —          | 23.2   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 5             | "            | 1,890  | —          | 20.8   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 6             | "            | 1,911  | —          | 15.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 7             | "            | 1,996  | —          | 20.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 8             | "            | 1,894  | —          | 21.8   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 9             | "            | 1,972  | —          | 22.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 10            | "            | 2,018  | —          | 23.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 11            | "            | 1,930  | —          | 20.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 12            | "            | 1,940  | —          | 18.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 13            | "            | 1,928  | —          | 18.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 14            | "            | 1,909  | —          | 24.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 15            | "            | 1,926  | —          | 19.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 16            | "            | 1,947  | —          | 23.2   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 17            | "            | 1,920  | —          | 17.2   | —      | Weather :—Clear.                                                                                                                                                  |          |              |       |    |       |    |
| 18            | "            | 1,896  | —          | 22.6   | —      | Wind :—Direction, W.S.W.; force, 3 ; 10 a.m.<br>"          "          S.          "          4 ; 3 p.m.                                                           |          |              |       |    |       |    |
| 19            | "            | 1,994  | —          | 16.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 20            | "            | 1,992  | —          | 15.0   | —      | Thermometer :—44 dry, 43 wet, 10 a.m.<br>45 " 44 " 3 p.m.                                                                                                         |          |              |       |    |       |    |
| 21            | "            | 1,928  | —          | 20.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 22            | "            | 2,024  | —          | 27.0   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.75</td><td>47</td></tr><tr><td>29.65</td><td>48</td></tr></table> 10 a.m.<br>3 p.m. | Reading. | Temperature. | 29.75 | 47 | 29.65 | 48 |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 29.75         | 47           |        |            |        |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 29.65         | 48           |        |            |        |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 23            | "            | 1,946  | —          | 18.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 24            | "            | 1,998  | —          | 20.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 25            | "            | 2,018  | —          | 20.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 26            | "            | 2,062  | —          | 19.2   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 27            | "            | 1,986  | —          | 24.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 28            | "            | 2,069  | —          | 15.8   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 29            | "            | 1,983  | —          | 14.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 30            | "            | 2,034  | —          | 16.8   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 31            | "            | 1,934  | —          | 21.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 32            | "            | 1,978  | —          | 20.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 33            | "            | 1,989  | —          | 21.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 34            | "            | 2,027  | —          | 21.8   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 35            | "            | 1,965  | —          | 16.8   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 36            | "            | 1,969  | —          | 19.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 37            | "            | 1,967  | —          | 16.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 38            | "            | 1,927  | —          | 13.6   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 39            | "            | 1,925  | —          | 23.0   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 40            | "            | 1,894  | —          | 15.8   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 41            | "            | 1,904  | —          | 17.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 42            | "            | 1,982  | —          | 17.4   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 43            | "            | 1,927  | —          | 19.2   | —      |                                                                                                                                                                   |          |              |       |    |       |    |
| 44            | "            | 1,934  | —          | 21.2   | —      |                                                                                                                                                                   |          |              |       |    |       |    |



## COMMITTEE'S PROGRAMME—continued.

| No. of Round. | Elevation. | Range. | 1st Graze. |        |       | Remarks.                                                                                                                           |
|---------------|------------|--------|------------|--------|-------|------------------------------------------------------------------------------------------------------------------------------------|
|               |            |        | In Line.   | Right. | Left. |                                                                                                                                    |
|               | °          | Yards. |            | Yards. |       |                                                                                                                                    |
| 1             | 10         | 4,400  | —          | 11·0   | —     | <i>November 23, 1864.</i><br><br>A. gun.<br><br> |
| 2             | "          | 4,200  | —          | 8·0    | —     |                                                                                                                                    |
| 3             | "          | 4,330  | Yes.       | —      | —     |                                                                                                                                    |
| 4             | "          | 4,380  | —          | 7·0    | —     |                                                                                                                                    |
| 5             | "          | 4,320  | —          | 14·0   | —     |                                                                                                                                    |
| 6             | "          | 4,270  | —          | 11·2   | —     |                                                                                                                                    |
| 7             | "          | 4,272  | —          | 3·2    | —     |                                                                                                                                    |
| 8             | "          | 4,310  | —          | 8·0    | —     |                                                                                                                                    |
| 9             | "          | 4,314  | —          | 10·0   | —     |                                                                                                                                    |
| 10            | "          | 4,230  | —          | 9·2    | —     |                                                                                                                                    |
| 11            | "          | 4,250  | —          | 15·0   | —     |                                                                                                                                    |
| 12            | "          | 4,220  | —          | —      | 0·2   |                                                                                                                                    |
| 13            | "          | 4,206  | —          | 17·2   | —     |                                                                                                                                    |
| 14            | "          | 4,196  | —          | 16·4   | —     |                                                                                                                                    |
| 15            | "          | 4,190  | —          | 16·0   | —     |                                                                                                                                    |
| 16            | "          | 4,236  | —          | 6·4    | —     |                                                                                                                                    |
| 17            | "          | 4,275  | —          | 3·2    | —     |                                                                                                                                    |
| 18            | "          | 4,360  | —          | 18·0   | —     |                                                                                                                                    |
| 19            | "          | 4,226  | —          | 6·0    | —     |                                                                                                                                    |
| 20            | "          | 4,307  | —          | 8·0    | —     |                                                                                                                                    |
| 21            | "          | 4,300  | —          | 15·0   | —     |                                                                                                                                    |
| 22            | "          | 4,300  | —          | 7·2    | —     |                                                                                                                                    |
| 23            | "          | 4,380  | —          | 12·0   | —     |                                                                                                                                    |
| 24            | "          | 4,250  | —          | 1·0    | —     |                                                                                                                                    |
| 25            | "          | 4,164  | —          | —      | 4·0   |                                                                                                                                    |
| 26            | "          | 4,283  | —          | 11·0   | —     |                                                                                                                                    |
| 27            | "          | 4,325  | —          | 3·0    | —     |                                                                                                                                    |
| 28            | "          | 4,245  | —          | 9·2    | —     |                                                                                                                                    |
| 29            | "          | 4,179  | —          | 3·2    | —     |                                                                                                                                    |
| 30            | "          | 4,240  | —          | 6·2    | —     |                                                                                                                                    |
| 31            | "          | 4,250  | —          | 21·0   | —     |                                                                                                                                    |
| 32            | "          | 4,259  | —          | 5·8    | —     |                                                                                                                                    |
| 33            | "          | 4,302  | —          | 13·4   | —     |                                                                                                                                    |
| 34            | "          | 4,300  | —          | 6·0    | —     |                                                                                                                                    |
| 35            | "          | 4,225  | —          | 19·0   | —     |                                                                                                                                    |
| 36            | "          | 4,305  | —          | 3·0    | —     |                                                                                                                                    |
| 37            | "          | 4,270  | —          | 10·6   | —     |                                                                                                                                    |
| 38            | "          | 4,253  | —          | 19·6   | —     |                                                                                                                                    |
| 39            | "          | 4,317  | —          | 3·8    | —     |                                                                                                                                    |
| 40            | "          | 4,271  | —          | 4·0    | —     |                                                                                                                                    |
| 41            | "          | 4,246  | —          | 10·0   | —     |                                                                                                                                    |
| 42            | "          | 4,339  | —          | 10·2   | —     |                                                                                                                                    |
| 43            | "          | 4,253  | —          | 12·0   | —     |                                                                                                                                    |
| 44            | "          | 4,257  | —          | 16·0   | —     |                                                                                                                                    |

COMMITTEE'S PROGRAMME—continued.

SOLID SHOT (WITHOUT LUBRICATORS).

| No. of Round. | Elevation. | Range. | 1st Graze. | Remarks.            |
|---------------|------------|--------|------------|---------------------|
|               |            |        | Right.     |                     |
|               | °          | Yards. | Yards.     | <i>May 2, 1865.</i> |
| 1             | 3          | 1,544  | 11.2       |                     |
| 2             | "          | 1,714  | 11.4       |                     |
| 3             | "          | 1,693  | 10.8       |                     |
| 4             | "          | 1,704  | 13.6       |                     |
| 5             | "          | 1,694  | 9.4        |                     |
| 6             | "          | 1,742  | 9.8        |                     |
| 7             | "          | 1,717  | 8.0        |                     |
| 8             | "          | 1,642  | 9.2        |                     |
| 9             | "          | 1,742  | 11.2       |                     |
| 10            | "          | 1,687  | 8.0        |                     |
| 11            | "          | 1,713  | 8.2        |                     |
| 12            | "          | 1,756  | 11.0       |                     |
| 13            | "          | 1,660  | 10.0       |                     |
| 14            | "          | 1,712  | 8.2        |                     |
| 15            | "          | 1,686  | 6.0        |                     |
| 16            | "          | 1,676  | 10.8       |                     |
| 17            | "          | 1,704  | 10.4       |                     |
| 18            | "          | 1,686  | 10.0       |                     |
| 19            | "          | 1,708  | 9.0        |                     |
| 20            | "          | 1,504  | 13.0       |                     |
| 21            | "          | 1,522  | 7.0        |                     |
| 22            | "          | 1,636  | 10.0       |                     |
| 1             | 6          | 2,770  | 14.2       |                     |
| 2             | "          | 3,044  | 17.0       |                     |
| 3             | "          | 3,135  | 14.4       |                     |
| 4             | "          | 3,112  | 14.6       |                     |
| 5             | "          | 3,107  | 15.0       |                     |
| 6             | "          | 3,119  | 11.8       |                     |
| 7             | "          | 3,087  | 18.0       |                     |
| 8             | "          | 3,106  | 10.6       |                     |
| 9             | "          | 3,102  | 16.8       |                     |
| 10            | "          | 3,132  | 14.0       |                     |
| 11            | "          | 3,104  | 11.0       |                     |
| 12            | "          | 3,089  | 10.0       |                     |
| 13            | "          | 3,091  | 17.4       |                     |
| 14            | "          | 2,845  | 25.4       |                     |
| 15            | "          | 3,090  | 19.0       |                     |
| 16            | "          | 3,134  | 12.6       |                     |
| 17            | "          | 3,141  | 19.2       |                     |
| 18            | "          | 3,103  | 13.4       |                     |
| 19            | "          | 3,165  | 15.6       |                     |
| 20            | "          | 3,137  | 16.0       |                     |
| 21            | "          | 3,091  | 8.0        |                     |
| 22            | "          | 3,126  | 14.0       |                     |

## PRACTICE AGAINST IRON PLATES.

June 23, 1864.

The practice was carried on against a target 10 × 20 feet, representing a section of the "Warrior," supported at the back in the usual manner.

RANGE, 800 yards.

Charge, 12 lbs.

|                               |       |          |
|-------------------------------|-------|----------|
|                               |       | lbs. oz. |
| Weight of steel shot          | - - - | 71 2     |
| Length, 12.66 inches.         |       |          |
| Diameter:—Major, 5.46 inches. |       |          |
| Minor, 4.98 inches.           |       |          |
| Weight of steel shell, empty  | - - - | 70 5     |
| Bursting charge               | - - - | 2 8      |
| Length, 16.4 inches.          |       |          |
| Diameter:—Major, 5.46 inches. |       |          |
| Minor, 4.98 inches.           |       |          |
| Number of the gun, 267.       |       |          |

1st Round—Shot.

Struck 4 feet 3 inches from the left edge, 4 feet from the bottom of the target; penetrated the plate; the shot broke off and part remained in the target; the depth in the backing could not be ascertained; damage in-board, one armour bolt broken off; left-hand bolt of plate slightly started.

2nd Round—Shot.

Penetrated the plate and remained bedded in the target its whole length; struck 8 feet from left edge and 6 feet from bottom of the target; the shot was cold.

3rd Round—Shell.

Struck 2 feet 9 inches from left edge and 2 feet  $8\frac{1}{2}$  inches from the bottom; made an indentation  $4\frac{1}{4}$  inches deep; exploded on the outside; drove the plate  $\frac{1}{2}$  an inch in; damage in-board, one rivet head broken.

June 24, 1864.

No. 267 gun.

RANGE, 50 yards.

1st Round—Shot.

Struck 9 feet 6 inches from left edge and 5 feet 4 inches from the bottom of the target; struck over horizontal stringer; the shot penetrated the plate and remained bedded in the target;  $2\frac{1}{2}$  inches of the base projected; the head of the shot set up and cracked; damage in-board, one bolt broken.

2nd Round—Shell.

Struck 2 feet 7 inches from the left edge and 3 feet 8 inches from the top edge of the target; the edge of the shell 1 inch from the join of two plates; shell penetrated the plate and broke up and fragments remained bedded  $6\frac{3}{4}$  inches in the target; plate driven back 1 inch and bent; left-hand end of plate started  $\frac{1}{4}$  inch from backing; damage in-board, one bolt broken.

RANGE, 600 yards.

1st Round—Shot.

Struck 10 feet 3 inches from left edge and 4 feet 7 inches from bottom;  $6\frac{1}{2}$  inches from the fracture caused by a former shot, and  $1\frac{1}{2}$  inches from the securing bolt; penetrated the plate and remained bedded in the target; 5 inches of the shot outside the plate; damage in-board, nil.

2nd Round—Shell.

Struck 7 feet 5 inches from right edge and 4 feet 4 inches from the bottom of the target, and 5 inches from the fracture caused by a former shell partially on a securing bolt; shell broke up; the fragments remained  $4\frac{1}{2}$  inches in the target; one crack extending from the bolt hole to a former fracture; damage in-board, two securing bolts broken.

June 27, 1864.

No. 267 gun.

RANGE, 200 yards.

1st Round—Shot.

Struck 5 feet  $2\frac{1}{2}$  inches from the right edge, 3 feet 6 inches from the bottom of the target, 6 inches from a securing bolt, and 6 inches from the former shot of the Armstrong gun; struck on the join of two plates; the shot stuck in the target, the base being  $4\frac{1}{2}$  inches outside the face of the plate; damage in-board, one backing and two securing bolts broken.

2nd Round—Shell.

Struck 5 feet  $7\frac{1}{2}$  inches from the left edge and 5 feet  $7\frac{1}{2}$  inches from the bottom of the target; the shell penetrated the plate and burst, some of the pieces remained bedded  $7\frac{1}{2}$  inches from the face of the plate; struck 3 inches from the Armstrong shot fired at 600 yards; no damage done to the bolts on the face; damage in-board, three backing bolts broken.

July 1, 1864.

RANGE, 50 yards.

Shell.

Struck 5 feet 9 inches from the left edge and 3 feet 3 inches from the bottom of the target; passed through the plate and burst; penetration, 18 inches; struck on the joint of the plates; one bolt started  $\frac{1}{4}$ th of an inch; damage in-board, skin bulged, three backing bolts and one armour bolt broken, one rib cracked.

## PRACTICE AGAINST ARMOUR PLATES PLACED AT AN ANGLE OF 52° FROM THE PERPENDICULAR.

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*April 26, 1865.*

RANGE, 200 yards.

Charge 12 lbs.

Steel shot, flat end.

The plates made by Petit, Gaudin, and Co. were 15 feet by 3 feet 4 inches by  $4\frac{1}{2}$  inches, and were supported on strong wood frames at an angle of 52°.

### *1st Round.*

Struck in the centre of the plate 6 feet, 3 inches from the bottom, made an indent 15 inches long, 6 inches broad, and 3 inches deep. Plate bulged and cracked at back.

### *2nd Round.*

Struck 2 feet 3 inches from the bottom of the plate,

made an indent 12 inches long,  $6\frac{1}{2}$  inches broad, and  $2\frac{1}{2}$  inches deep; the plate was slightly bulged at the back, but not cracked.

Shot broke up.

### *3rd Round.*

To test the uniformity of the plates this round was fired at the plate previously struck by the Armstrong shot.

Struck 3 feet 2 inches from the bottom and in the centre of the plate.

Made an indent 11 inches long, 6 inches broad, and  $2\frac{3}{4}$  inches deep; the back of the plate was slightly bulged, but not cracked.

The shot broke up.

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## RAPID FIRING.

*July 6, 1864.*

The gun was mounted on a rear chock carriage on an ordinary ground platform and worked by men of the Royal Artillery.

The detachments were changed every 20 rounds.

### *Solid Shot.*

|                                   |                           |
|-----------------------------------|---------------------------|
| The 1st 20 rounds were fired in - | 19 $\frac{1}{2}$ minutes. |
| 2nd    "           "              | - 23   "                  |
| 3rd    "           "              | - 24 $\frac{1}{2}$ "      |
| 4th    "           "              | - 22   "                  |
| 5th    "           "              | - 22   "                  |
| 6th    "           "              | - 16   "                  |

The ordinary lubricator with cardboard hexagons on either side was used.

The usual bristle sponge was used.

This gun was loaded with very great ease throughout.

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25 rounds, rapid firing, were fired with 12 lbs. charges.

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# 70-POUNDER MUZZLE-LOADING ARMSTRONG GUN.

## EXPERIMENTS FOR DETERMINING RANGE AND ACCURACY.

N.B. The figures in *Italics* are the rounds struck out by the competitors as abnormal shots.

SHOT (HOLLOW HEADED.)

SHOEBURYNESS.

*Particulars of Gun.*  
 Weight, 75 cwt.  
 Length, 10 ft. 3.25 in.  
 Diameter of bore, 6.4 in.  
 Length of bore, 9 feet.  
 Grooves, No. 3.  
 Windage, 0.06 in.  
 Spiral, 1 turn in 256 inches, 40 calibres nearly.

*Particulars of Ammunition.*  
 Weight, 70.6 lbs.  
 Diameter, 6.34 in.  
 Length, 12.81 in.  
 No. of buttons, 15 in 3 rows.  
 Projection of buttons, .11 in.  
 Breadth of buttons at top, .45 in.  
 " " at bottom, .59 in.  
 Length of cartridge, 12 in.  
 Diameter of cartridge, 5 in.  
 Brand of powder, A 4.  
 Charge, 10 lbs.  
 Wad, Boxer's lubricator, filled with oil.

| No. of Round.     | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                              |          |              |       |    |
|-------------------|--------------|--------|------------|--------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|                   |              |        |            | Right. |                                                                                                                       |          |              |       |    |
|                   | °            | Yards. | Yards.     |        | October 14, 1864.                                                                                                     |          |              |       |    |
| 1                 | 0            | 490    | 12.8       |        |                                                                                                                       |          |              |       |    |
| 2                 | "            | 489    | 14.0       |        |                                                                                                                       |          |              |       |    |
| 3                 | "            | 486    | 14.0       |        |                                                                                                                       |          |              |       |    |
| 4                 | "            | 462    | 14.0       |        |                                                                                                                       |          |              |       |    |
| 5                 | "            | 504    | 13.4       |        |                                                                                                                       |          |              |       |    |
| 6                 | "            | 485    | 14.0       |        | The gun was 39 feet right of line.                                                                                    |          |              |       |    |
| 7                 | "            | 503    | 13.0       |        |                                                                                                                       |          |              |       |    |
| 8                 | "            | 475    | 13.6       |        | Weather :— Very thick haze.                                                                                           |          |              |       |    |
| 9                 | "            | 487    | 14.0       |        |                                                                                                                       |          |              |       |    |
| 10                | "            | 499    | 14.2       |        | Wind :—Direction, N.W. ; force, 2 ; 10 a.m.                                                                           |          |              |       |    |
| 11                | "            | 474    | 13.4       |        | " " " 2 ; 3 p.m.                                                                                                      |          |              |       |    |
| 12                | "            | 491    | 12.8       |        |                                                                                                                       |          |              |       |    |
| 13                | "            | 493    | 14.0       |        | Thermometer :—53 dry, 52 wet, 10 a.m.                                                                                 |          |              |       |    |
| 14                | "            | 492    | 13.8       |        | 57 " 55 " 3 p.m.                                                                                                      |          |              |       |    |
| 15                | "            | 504    | 13.6       |        |                                                                                                                       |          |              |       |    |
| 16                | "            | 467    | 14.0       |        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.05</td><td>56</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.05 | 56 |
| Reading.          | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 30.05             | 56           |        |            |        |                                                                                                                       |          |              |       |    |
| 17                | "            | 476    | 13.6       |        | 30.10 56 3 p.m.                                                                                                       |          |              |       |    |
| 18                | "            | 504    | 13.8       |        |                                                                                                                       |          |              |       |    |
| 19                | "            | 488    | 13.8       |        |                                                                                                                       |          |              |       |    |
| 20                | "            | 480    | 13.0       |        |                                                                                                                       |          |              |       |    |
| 21                | "            | 461    | 13.8       |        |                                                                                                                       |          |              |       |    |
| 22                | "            | 466    | 13.4       |        |                                                                                                                       |          |              |       |    |
| October 12, 1864. |              |        |            |        |                                                                                                                       |          |              |       |    |
| 1                 | 3            | 1,600  | 21.6       |        |                                                                                                                       |          |              |       |    |
| 2                 | "            | 1,602  | 20.6       |        |                                                                                                                       |          |              |       |    |
| 3                 | "            | 1,598  | 18.2       |        |                                                                                                                       |          |              |       |    |
| 4                 | "            | 1,615  | 21.4       |        |                                                                                                                       |          |              |       |    |
| 5                 | "            | 1,616  | 19.2       |        |                                                                                                                       |          |              |       |    |
| 6                 | "            | 1,593  | 20.0       |        |                                                                                                                       |          |              |       |    |
| 7                 | "            | 1,649  | 22.0       |        |                                                                                                                       |          |              |       |    |
| 8                 | "            | 1,602  | 19.0       |        |                                                                                                                       |          |              |       |    |
| 9                 | "            | 1,657  | 21.8       |        |                                                                                                                       |          |              |       |    |
| 10                | "            | 1,594  | 19.0       |        |                                                                                                                       |          |              |       |    |
| 11                | "            | 1,675  | 21.6       |        |                                                                                                                       |          |              |       |    |
| 12                | "            | 1,616  | 21.4       |        | The gun was 39 feet right of line.                                                                                    |          |              |       |    |
| 13                | "            | 1,654  | 17.6       |        |                                                                                                                       |          |              |       |    |
| 14                | "            | 1,633  | 20.6       |        | Weather :—Hazy.                                                                                                       |          |              |       |    |
| 15                | "            | 1,628  | 20.6       |        |                                                                                                                       |          |              |       |    |
| 16                | "            | 1,600  | 20.4       |        | Wind :—Direction, N.N.W. ; force, 3 ; 10 a.m.                                                                         |          |              |       |    |
| 17                | "            | 1,586  | 16.2       |        | " N.W. by N. ; " 3 ; 3 p.m.                                                                                           |          |              |       |    |
| 18                | "            | 1,614  | 21.0       |        |                                                                                                                       |          |              |       |    |
| 19                | "            | 1,581  | 19.0       |        | Thermometer :—54 dry, 52 wet, 10 a.m.                                                                                 |          |              |       |    |
| 20                | "            | 1,605  | 22.0       |        | 56 " 54 " 3 p.m.                                                                                                      |          |              |       |    |
| 21                | "            | 1,582  | 22.4       |        |                                                                                                                       |          |              |       |    |
| 22                | "            | 1,544  | 17.6       |        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.30</td><td>55</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.30 | 55 |
| Reading.          | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 30.30             | 55           |        |            |        |                                                                                                                       |          |              |       |    |
| 23                | "            | 1,611  | 20.8       |        | 30.28 70 3 p.m.                                                                                                       |          |              |       |    |
| 24                | "            | 1,650  | 22.0       |        |                                                                                                                       |          |              |       |    |
| 25                | "            | 1,600  | 19.0       |        |                                                                                                                       |          |              |       |    |
| 26                | "            | 1,582  | 22.4       |        |                                                                                                                       |          |              |       |    |
| 27                | "            | 1,598  | 18.4       |        |                                                                                                                       |          |              |       |    |
| 28                | "            | 1,613  | 17.6       |        |                                                                                                                       |          |              |       |    |
| 29                | "            | 1,625  | 20.0       |        |                                                                                                                       |          |              |       |    |
| 30                | "            | 1,608  | 19.0       |        |                                                                                                                       |          |              |       |    |
| 31                | "            | 1,633  | 19.6       |        |                                                                                                                       |          |              |       |    |
| 32                | "            | 1,664  | 18.0       |        |                                                                                                                       |          |              |       |    |
| 33                | "            | 1,597  | 18.0       |        |                                                                                                                       |          |              |       |    |







## RANGE AND ACCURACY.—SHOT—continued.

| No. of Round. | Elevation.   | Range. | 1st Graze. | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|---------------|--------------|--------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | Right.     |                                                                                                                                                         |          |              |       |    |       |    |
|               | °            | Yards. | Yards.     |                                                                                                                                                         |          |              |       |    |       |    |
| 1             | 12           | 4,309  | 32.0       | March 2, 1865.                                                                                                                                          |          |              |       |    |       |    |
| 2             | "            | 4,498  | 40.8       |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 4,537  | 32.6       |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "            | 4,539  | 24.0       |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "            | 4,602  | 23.2       |                                                                                                                                                         |          |              |       |    |       |    |
| 6             | "            | 4,497  | 36.4       | The gun was 39 feet right of line.                                                                                                                      |          |              |       |    |       |    |
| 7             | "            | 4,698  | 20.4       | Weather :—Foggy and raining, 10 a.m.                                                                                                                    |          |              |       |    |       |    |
| 8             | "            | 4,507  | 28.8       | Slight haze, 3 p.m.                                                                                                                                     |          |              |       |    |       |    |
| 9             | "            | 4,457  | 21.2       |                                                                                                                                                         |          |              |       |    |       |    |
| 10            | "            | 4,407  | 31.8       | Wind :—Direction, N.W. by W. ; force, 4 ; 10 a.m.                                                                                                       |          |              |       |    |       |    |
| 11            | "            | 4,563  | 27.4       | " " N.W. ; " 4 ; 3 a.m.                                                                                                                                 |          |              |       |    |       |    |
| 12            | "            | 4,613  | 30.2       |                                                                                                                                                         |          |              |       |    |       |    |
| 13            | "            | 4,573  | 25.0       | Thermometer :—44 dry, 44 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 14            | "            | 4,527  | 24.0       | 46 " 45 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 15            | "            | 4,675  | 23.6       |                                                                                                                                                         |          |              |       |    |       |    |
| 16            | "            | 4,561  | 34.6       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.70</td><td>46</td></tr><tr><td>29.70</td><td>48</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.70 | 46 | 29.70 | 48 |
| Reading.      | Temperature. |        |            |                                                                                                                                                         |          |              |       |    |       |    |
| 29.70         | 46           |        |            |                                                                                                                                                         |          |              |       |    |       |    |
| 29.70         | 48           |        |            |                                                                                                                                                         |          |              |       |    |       |    |
| 17            | "            | 4,235  | 48.8       | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 18            | "            | 4,531  | 28.6       |                                                                                                                                                         |          |              |       |    |       |    |
| 19            | "            | 4,657  | 31.8       |                                                                                                                                                         |          |              |       |    |       |    |
| 20            | "            | 4,573  | 38.6       |                                                                                                                                                         |          |              |       |    |       |    |
| 21            | "            | 4,595  | 21.8       |                                                                                                                                                         |          |              |       |    |       |    |
| 22            | "            | 4,571  | 34.2       |                                                                                                                                                         |          |              |       |    |       |    |
|               |              |        |            | October 27, 1864.                                                                                                                                       |          |              |       |    |       |    |
| 1             | 15           | 5,360  | 73.0       | The gun was 39 feet right of line.                                                                                                                      |          |              |       |    |       |    |
| 2             | "            | 5,418  | 84.0       | Weather :—Foggy.                                                                                                                                        |          |              |       |    |       |    |
| 3             | "            | 5,391  | 92.0       | Wind :—Direction, N. ; force, 1 ; 10 a.m.                                                                                                               |          |              |       |    |       |    |
| 4             | "            | 5,364  | 76.0       | " W. by N. ; " 2 ; 3 p.m.                                                                                                                               |          |              |       |    |       |    |
| 5             | "            | 5,275  | 82.0       | Thermometer :—55 dry, 54 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 6             | "            | 5,364  | 81.0       | 56 " 56 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 7             | "            | 5,386  | 103.0      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.28</td><td>56</td></tr><tr><td>29.35</td><td>56</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.28 | 56 | 29.35 | 56 |
| Reading.      | Temperature. |        |            |                                                                                                                                                         |          |              |       |    |       |    |
| 29.28         | 56           |        |            |                                                                                                                                                         |          |              |       |    |       |    |
| 29.35         | 56           |        |            |                                                                                                                                                         |          |              |       |    |       |    |
| 8             | "            | 5,324  | 93.0       | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
|               |              |        |            | October 28, 1864.                                                                                                                                       |          |              |       |    |       |    |
| 1             | 15           | 5,093  | 105.0      | The gun was 39 feet right of line.                                                                                                                      |          |              |       |    |       |    |
| 2             | "            | 5,050  | 102.0      | Weather :—Thick haze on water, 10 a.m.                                                                                                                  |          |              |       |    |       |    |
| 3             | "            | 5,025  | 103.0      | Slight haze, 3 p.m.                                                                                                                                     |          |              |       |    |       |    |
| 4             | "            | 5,055  | 107.0      | Wind :—Direction, N.E. by E. ; force, 1 ; 10 a.m.                                                                                                       |          |              |       |    |       |    |
| 5             | "            | 5,105  | 104.0      | " E. by N. ; " 3 ; 3 p.m.                                                                                                                               |          |              |       |    |       |    |
| 6             | "            | 5,146  | 109.0      | Thermometer :—56 dry, 55 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 7             | "            | 5,048  | 103.0      | 57 " 56 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 8             | "            | 5,128  | 110.0      |                                                                                                                                                         |          |              |       |    |       |    |
| 9             | "            | 5,096  | 106.0      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.55</td><td>58</td></tr><tr><td>29.55</td><td>57</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.55 | 58 | 29.55 | 57 |
| Reading.      | Temperature. |        |            |                                                                                                                                                         |          |              |       |    |       |    |
| 29.55         | 58           |        |            |                                                                                                                                                         |          |              |       |    |       |    |
| 29.55         | 57           |        |            |                                                                                                                                                         |          |              |       |    |       |    |
| 10            | "            | 5,088  | 105.0      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 11            | "            | 5,055  | 115.0      |                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "            | 5,114  | 103.0      |                                                                                                                                                         |          |              |       |    |       |    |
|               |              |        |            | June 21, 1865.                                                                                                                                          |          |              |       |    |       |    |
| 1             | 15           | 5,144  | 65.0       |                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "            | 5,356  | 46.2       |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 5,360  | 48.0       |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "            | 5,167  | 23.0       |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "            | 5,298  | 53.4       |                                                                                                                                                         |          |              |       |    |       |    |
| 6             | "            | 5,356  | 47.0       |                                                                                                                                                         |          |              |       |    |       |    |
| 7             | "            | 5,350  | 36.0       | Weather :—Clear.                                                                                                                                        |          |              |       |    |       |    |
| 8             | "            | 5,262  | 23.0       |                                                                                                                                                         |          |              |       |    |       |    |
| 9             | "            | 5,180  | 35.0       | Wind :—Direction, S.E. by S. ; force, 2 ; 10 a.m.                                                                                                       |          |              |       |    |       |    |
| 10            | "            | 5,380  | 37.0       | " " " 2 ; 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 11            | "            | 5,292  | 36.0       |                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "            | 5,324  | 37.0       | Thermometer :—67 dry, 64 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 13            | "            | 4,950  | 36.0       | 70 " 66 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 14            | "            | 5,422  | 48.0       |                                                                                                                                                         |          |              |       |    |       |    |
| 15            | "            | 5,378  | 42.0       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.40</td><td>67</td></tr><tr><td>30.40</td><td>67</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.40 | 67 | 30.40 | 67 |
| Reading.      | Temperature. |        |            |                                                                                                                                                         |          |              |       |    |       |    |
| 30.40         | 67           |        |            |                                                                                                                                                         |          |              |       |    |       |    |
| 30.40         | 67           |        |            |                                                                                                                                                         |          |              |       |    |       |    |
| 16            | "            | 5,126  | 36.0       | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 17            | "            | 5,284  | 33.0       |                                                                                                                                                         |          |              |       |    |       |    |
| 18            | "            | 5,323  | 39.0       |                                                                                                                                                         |          |              |       |    |       |    |
| 19            | "            | 5,335  | 42.0       |                                                                                                                                                         |          |              |       |    |       |    |
| 20            | "            | 5,190  | 38.0       |                                                                                                                                                         |          |              |       |    |       |    |
| 21            | "            | 5,277  | 47.0       |                                                                                                                                                         |          |              |       |    |       |    |
| 22            | "            | 5,269  | 34.0       |                                                                                                                                                         |          |              |       |    |       |    |
| 23            | "            | 5,190  | 45.0       |                                                                                                                                                         |          |              |       |    |       |    |

## RANGE AND ACCURACY.—SHOT—continued.

| No. of Round.      | Elevation.   | Range. | 1st Graze. | Remarks.                                                                                                              |          |              |       |    |
|--------------------|--------------|--------|------------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|                    |              |        | Right.     |                                                                                                                       |          |              |       |    |
| November 22, 1864. |              |        |            |                                                                                                                       |          |              |       |    |
|                    | °            | Yards. | Yards.     |                                                                                                                       |          |              |       |    |
| 1                  | 21           | 6,120  | 120.0      |                                                                                                                       |          |              |       |    |
| 2                  | "            | 6,560  | 206.0      |                                                                                                                       |          |              |       |    |
| 3                  | "            | 6,520  | 193.0      |                                                                                                                       |          |              |       |    |
| 4                  | "            | 6,340  | 156.0      | The gun was 9 feet right of line.                                                                                     |          |              |       |    |
| 5                  | "            | 6,494  | 194.0      |                                                                                                                       |          |              |       |    |
| 6                  | "            | 6,100  | 180.0      | Weather :—Hazy and raining, 10 a.m.                                                                                   |          |              |       |    |
| 7                  | "            | 6,360  | 181.0      | Clearing up, 3 p.m.                                                                                                   |          |              |       |    |
| 8                  | "            | 6,528  | 193.0      |                                                                                                                       |          |              |       |    |
| 9                  | "            | 6,512  | 176.0      | Wind :—Direction, W.S.W. ; force, 3 ; 10 a.m.                                                                         |          |              |       |    |
| 10                 | "            | 6,206  | 182.0      | " N.W. by W. ; " 5 ; 3 p.m.                                                                                           |          |              |       |    |
| 11                 | "            | 6,329  | 169.0      |                                                                                                                       |          |              |       |    |
| 12                 | "            | 6,132  | 171.0      | Thermometer :—49 dry, 49 wet, 10 a.m.                                                                                 |          |              |       |    |
| 13                 | "            | 6,250  | 190.0      | 49 " 47 " 3 p.m.                                                                                                      |          |              |       |    |
| 14                 | "            | 6,264  | 194.0      |                                                                                                                       |          |              |       |    |
| 15                 | "            | 6,200  | 183.0      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.65</td><td>51</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.65 | 51 |
| Reading.           | Temperature. |        |            |                                                                                                                       |          |              |       |    |
| 29.65              | 51           |        |            |                                                                                                                       |          |              |       |    |
| 16                 | "            | 6,225  | 170.0      | <table><tr><td>29.55</td><td>52</td></tr></table> 3 p.m.                                                              | 29.55    | 52           |       |    |
| 29.55              | 52           |        |            |                                                                                                                       |          |              |       |    |
| 17                 | "            | 6,316  | 173.0      |                                                                                                                       |          |              |       |    |
| 18                 | "            | 6,524  | 208.0      |                                                                                                                       |          |              |       |    |
| 19                 | "            | 6,236  | 177.0      |                                                                                                                       |          |              |       |    |
| 20                 | "            | 6,412  | 186.0      |                                                                                                                       |          |              |       |    |
| February 21, 1865. |              |        |            |                                                                                                                       |          |              |       |    |
| 1                  | 3            | 1,518  | 22.0       |                                                                                                                       |          |              |       |    |
| 2                  | "            | 1,600  | 19.4       |                                                                                                                       |          |              |       |    |
| 3                  | "            | 1,645  | 20.2       |                                                                                                                       |          |              |       |    |
| 4                  | "            | 1,634  | 19.2       |                                                                                                                       |          |              |       |    |
| 5                  | "            | 1,635  | 19.0       | The gun was 39 feet right of line.                                                                                    |          |              |       |    |
| 6                  | "            | 1,660  | 18.4       |                                                                                                                       |          |              |       |    |
| 7                  | "            | 1,617  | 19.6       | Cartridges filled with L.G. powder.                                                                                   |          |              |       |    |
| 8                  | "            | 1,635  | 19.2       |                                                                                                                       |          |              |       |    |
| 9                  | "            | 1,631  | 18.6       | Weather :—Hazy, 10 a.m.                                                                                               |          |              |       |    |
| 10                 | "            | 1,682  | 20.0       | Hazy and snowing, 3 p.m.                                                                                              |          |              |       |    |
| 11                 | "            | 1,635  | 17.6       |                                                                                                                       |          |              |       |    |
| 12                 | "            | 1,662  | 18.0       | Wind :—Direction, N.W. ; force, 3 ; 10 a.m.                                                                           |          |              |       |    |
| 13                 | "            | 1,557  | 20.6       | " W. " 3 ; 3 p.m.                                                                                                     |          |              |       |    |
| 14                 | "            | 1,671  | 21.0       |                                                                                                                       |          |              |       |    |
| 15                 | "            | 1,665  | 20.2       | Thermometer :—32 dry, 31 wet, 10 a.m.                                                                                 |          |              |       |    |
| 16                 | "            | 1,649  | 20.4       | 34 " 32 " 3 p.m.                                                                                                      |          |              |       |    |
| 17                 | "            | 1,641  | 19.2       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.38</td><td>37</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.38 | 37 |
| Reading.           | Temperature. |        |            |                                                                                                                       |          |              |       |    |
| 30.38              | 37           |        |            |                                                                                                                       |          |              |       |    |
| 18                 | "            | 1,651  | 22.0       | <table><tr><td>30.30</td><td>39</td></tr></table> 3 p.m.                                                              | 30.30    | 39           |       |    |
| 30.30              | 39           |        |            |                                                                                                                       |          |              |       |    |
| 19                 | "            | 1,654  | 19.6       |                                                                                                                       |          |              |       |    |
| 20                 | "            | 1,608  | 21.2       |                                                                                                                       |          |              |       |    |
| 21                 | "            | 1,629  | 19.2       |                                                                                                                       |          |              |       |    |
| 22                 | "            | 1,671  | 19.6       |                                                                                                                       |          |              |       |    |
| March 10, 1865.    |              |        |            |                                                                                                                       |          |              |       |    |
| 1                  | 6            | 2,753  | 28.4       |                                                                                                                       |          |              |       |    |
| 2                  | "            | 2,800  | 30.0       |                                                                                                                       |          |              |       |    |
| 3                  | "            | 2,786  | 26.8       |                                                                                                                       |          |              |       |    |
| 4                  | "            | 2,798  | 24.4       |                                                                                                                       |          |              |       |    |
| 5                  | "            | 2,750  | 29.2       |                                                                                                                       |          |              |       |    |
| 6                  | "            | 2,735  | 23.0       |                                                                                                                       |          |              |       |    |
| 7                  | "            | 2,767  | 28.4       |                                                                                                                       |          |              |       |    |
| 8                  | "            | 2,813  | 27.8       |                                                                                                                       |          |              |       |    |
| 9                  | "            | 2,725  | 26.0       |                                                                                                                       |          |              |       |    |
| 10                 | "            | 2,743  | 25.4       | The gun was 39 feet right of line.                                                                                    |          |              |       |    |
| 11                 | "            | 2,794  | 24.8       |                                                                                                                       |          |              |       |    |
| 12                 | "            | 2,704  | 26.0       | Cartridges filled with L.G. powder.                                                                                   |          |              |       |    |
| 13                 | "            | 2,815  | 25.4       |                                                                                                                       |          |              |       |    |
| 14                 | "            | 2,755  | 22.0       |                                                                                                                       |          |              |       |    |
| 15                 | "            | 2,770  | 24.2       |                                                                                                                       |          |              |       |    |
| 16                 | "            | 2,749  | 23.4       |                                                                                                                       |          |              |       |    |
| 17                 | "            | 2,742  | 24.0       |                                                                                                                       |          |              |       |    |
| 18                 | "            | 2,748  | 22.6       |                                                                                                                       |          |              |       |    |
| 19                 | "            | 2,802  | 24.4       |                                                                                                                       |          |              |       |    |
| 20                 | "            | 2,764  | 25.0       |                                                                                                                       |          |              |       |    |
| 21                 | "            | 2,675  | 22.2       |                                                                                                                       |          |              |       |    |
| 22                 | "            | 2,754  | 21.8       |                                                                                                                       |          |              |       |    |

## RANGE AND ACCURACY.—SHOT—continued.

AFTER FIRING 3,000 ROUNDS.

| No. of Round. | Elevation. | Range. | 1st Graze. | Remarks.                                                                  |
|---------------|------------|--------|------------|---------------------------------------------------------------------------|
|               |            |        | Right.     |                                                                           |
|               | °          | Yards. | Yards.     | June 19, 1865.                                                            |
| 1             | 6          | 2,628  | 19.0       |                                                                           |
| 2             | "          | 2,660  | 23.0       |                                                                           |
| 3             | "          | 2,687  | 25.6       |                                                                           |
| 4             | "          | 2,704  | 27.6       |                                                                           |
| 5             | "          | 2,673  | 30.0       |                                                                           |
| 6             | "          | 2,608  | 25.4       |                                                                           |
| 7             | "          | 2,684  | 34.0       |                                                                           |
| 8             | "          | 2,667  | 30.6       |                                                                           |
| 9             | "          | 2,728  | 24.0       |                                                                           |
| 10            | "          | 2,738  | 28.0       |                                                                           |
| 11            | "          | 2,654  | 26.0       |                                                                           |
| 12            | "          | 2,700  | 27.0       |                                                                           |
| 13            | "          | 2,632  | 24.0       | Weather :—Clear.                                                          |
| 14            | "          | 2,648  | 29.0       |                                                                           |
| 15            | "          | 2,697  | 25.4       | Wind :—Direction, E.N.E. ; force, 2 ; 10 a.m.                             |
| 16            | "          | 2,645  | 23.0       | „ S.E. by E. ; „ 2 ; 3 p.m.                                               |
| 17            | "          | 2,672  | 26.0       |                                                                           |
| 18            | "          | 2,587  | 19.0       | Thermometer :—56 dry, 54 wet, 10 a.m.                                     |
| 19            | "          | 2,685  | 20.0       | 61 „ 59 „ 3 p.m.                                                          |
| 20            | "          | 2,630  | 24.6       |                                                                           |
| 21            | "          | 2,658  | 21.6       |                                                                           |
| 22            | "          | 2,702  | 18.4       | Barometer :— <sup>Reading.</sup> 29.90 <sup>Temperature,</sup> 58 10 a.m. |
| 23            | "          | 2,673  | 18.0       | 30.35 60 3 p.m.                                                           |
| 24            | "          | 2,700  | 21.0       |                                                                           |
| 25            | "          | 2,730  | 18.0       |                                                                           |
| 26            | "          | 2,602  | 21.0       |                                                                           |
| 27            | "          | 2,656  | 20.0       |                                                                           |
| 28            | "          | 2,698  | 23.0       |                                                                           |
| 29            | "          | 2,567  | 20.0       |                                                                           |
| 30            | "          | 2,708  | 17.6       |                                                                           |
| 31            | "          | 2,712  | 23.0       |                                                                           |
| 32            | "          | 2,623  | 19.6       |                                                                           |
| 33            | "          | 2,683  | 23.0       |                                                                           |



RANGE AND ACCURACY.—COMMON SHELL—*continued.*

| No. of Rounds. | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |              |       |    |       |    |
|----------------|--------------|--------|------------|--------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|                |              |        | In Line.   | Right. | Left.  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
|                | °            | Yards. |            | Yards. | Yards. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 1              | 4            | 1,769  | —          | 12.0   | —      | November 22, 1864.<br><br>The gun was 19 feet right of line.<br><br>Weather :—Hazy and raining, 10 a.m.<br>Clearing up, 3 p.m.<br><br>Wind :—Direction, W.S.W. ; force, 3 ; 10 a.m.<br>,, N.W. by W.   ,, 5 ; 3 p.m.<br><br>Thermometer :—49 dry, 49 wet, 10 a.m.<br>49   ,, 47   ,, 3 p.m.<br><br>Barometer:— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.65</td><td>51</td></tr><tr><td>29.55</td><td>52</td></tr></table> 10 a.m.<br>3 p.m. | Reading. | Temperature. | 29.65 | 51 | 29.55 | 52 |
| Reading.       | Temperature. |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 29.65          | 51           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 29.55          | 52           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 2              | "            | 1,772  | —          | 13.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 3              | "            | 1,750  | —          | 12.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 4              | "            | 1,802  | —          | 12.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 5              | "            | 1,790  | —          | 9.8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 6              | "            | 1,837  | —          | 10.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 7              | "            | 1,801  | —          | 12.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 8              | "            | 1,825  | —          | 10.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 9              | "            | 1,776  | —          | 9.0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 10             | "            | 1,826  | —          | 12.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 11             | "            | 1,756  | —          | 11.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 12             | "            | 1,778  | —          | 9.4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 13             | "            | 1,708  | —          | 9.0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 14             | "            | 1,830  | —          | 9.8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 15             | "            | 1,816  | —          | 11.2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 16             | "            | 1,736  | —          | 8.8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 17             | "            | 1,818  | —          | 12.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 18             | "            | 1,729  | —          | 10.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 19             | "            | 1,792  | —          | 10.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 20             | "            | 1,814  | —          | 12.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 21             | "            | 1,838  | —          | 11.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 22             | "            | 1,790  | —          | 12.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 23             | "            | 1,802  | —          | 8.8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 24             | "            | 1,832  | —          | 11.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 25             | "            | 1,906  | —          | 10.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 26             | "            | 1,801  | —          | 10.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 27             | "            | 1,890  | —          | 10.8   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 28             | "            | 1,802  | —          | 10.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 29             | "            | 1,808  | —          | 10.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 30             | "            | 1,843  | —          | 11.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 31             | "            | 1,838  | —          | 10.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 32             | "            | 1,818  | —          | 10.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 33             | "            | 1,859  | —          | 11.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
|                |              |        |            |        |        | November 21, 1864.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |              |       |    |       |    |
| 1              | 7            | 2,924  | —          | 16.0   | —      | November 21, 1864.<br><br>The gun was 19 feet right of line.<br><br>Weather :—Hazy.<br><br>Wind :—Direction, N.W. by W. ; force 2 ; 10 a.m.<br>,, S.W. by W.   ,, 3 ; 3 p.m.<br><br>Thermometer :—45 dry, 44 wet, 10 a.m.<br>49   ,, 48   ,, 3 p.m.<br><br>Barometer:— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.88</td><td>49</td></tr><tr><td>29.90</td><td>51</td></tr></table> 10 a.m.<br>3 p.m.                                         | Reading. | Temperature. | 29.88 | 49 | 29.90 | 51 |
| Reading.       | Temperature. |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 29.88          | 49           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 29.90          | 51           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 2              | "            | 2,982  | —          | 15.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 3              | "            | 2,987  | —          | 20.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 4              | "            | 2,984  | —          | 20.8   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 5              | "            | 3,070  | —          | 27.2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 6              | "            | 2,967  | —          | 24.2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 7              | "            | 2,969  | —          | 24.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 8              | "            | 3,157  | —          | 23.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 9              | "            | 3,094  | —          | 27.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 10             | "            | 3,005  | —          | 21.8   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 11             | "            | 3,067  | —          | 28.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 12             | "            | 2,981  | —          | 25.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 13             | "            | 3,131  | —          | 23.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 14             | "            | 3,136  | —          | 22.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 15             | "            | 3,094  | —          | 20.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 16             | "            | 2,954  | —          | 22.2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 17             | "            | 3,004  | —          | 19.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 18             | "            | 2,939  | —          | 21.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 19             | "            | 2,944  | —          | 21.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 20             | "            | 2,962  | —          | 22.2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 21             | "            | 2,935  | —          | 23.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 22             | "            | 2,940  | —          | 20.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 23             | "            | 2,931  | —          | 22.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 24             | "            | 3,068  | —          | 20.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 25             | "            | 2,982  | —          | 21.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 26             | "            | 2,931  | —          | 21.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 27             | "            | 3,157  | —          | 18.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 28             | "            | 2,957  | —          | 18.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 29             | "            | 2,996  | —          | 18.2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 30             | "            | 3,135  | —          | 18.8   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 31             | "            | 3,000  | —          | 18.2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 32             | "            | 3,114  | —          | 18.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 33             | "            | 2,984  | —          | 24.2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 34             | "            | 3,114  | —          | 18.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 35             | "            | 2,915  | —          | 20.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 36             | "            | 3,178  | —          | 18.8   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 37             | "            | 3,166  | —          | 22.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |
| 38             | "            | 3,158  | —          | 23.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |              |       |    |       |    |



RANGE AND ACCURACY.—COMMON SHELL—*continued.*

| No. of Rounds.     | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |              |       |    |       |    |
|--------------------|--------------|--------|------------|--------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|                    |              |        | In Line.   | Right. | Left.  |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
|                    | °            | Yards. |            | Yards. | Yards. |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 1                  | 10           | 3,804  | —          | 34.0   | —      | November 10, 1864.<br><br>Corresponding round, Whitworth, broke up.<br><br>The gun was 9 feet left of line.<br>Weather :—Clear.<br>Wind :—Direction, E.S.E. ; force, 5 ; 10 a.m.<br>E. by S. „ 3 ; 3 p.m.<br>Thermometer :—43 dry, 41 wet, 10 a.m.<br>43 „ 41 „ 3 p.m.<br>Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.10</td><td>47</td></tr><tr><td>30.05</td><td>46</td></tr></table> 10 a.m.<br>3 p.m. | Reading. | Temperature. | 30.10 | 47 | 30.05 | 46 |
| Reading.           | Temperature. |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 30.10              | 47           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 30.05              | 46           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 2                  | „            | 3,750  | —          | 34.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 3                  | „            | 3,646  | —          | 36.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 4                  | „            | 3,797  | —          | 35.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 5                  | „            | 3,689  | —          | 38.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 6                  | „            | 3,700  | —          | 37.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 7                  | „            | 3,771  | —          | 35.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 8                  | „            | 3,846  | —          | 44.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 9                  | „            | 3,723  | —          | 38.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 10                 | „            | 3,770  | —          | 35.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 11                 | „            | 3,760  | —          | 31.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 12                 | „            | 3,750  | —          | 30.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 13                 | „            | 3,832  | —          | 32.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 14                 | „            | 3,880  | —          | 36.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 15                 | „            | 3,846  | —          | 38.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 16                 | „            | 3,809  | —          | 39.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 17                 | „            | 3,786  | —          | 40.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 18                 | „            | 3,695  | —          | 34.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 19                 | „            | 3,804  | —          | 32.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 20                 | „            | 3,843  | —          | 41.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 21                 | „            | 3,800  | —          | 33.6   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 22                 | „            | 3,864  | —          | 38.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 23                 | „            | 3,776  | —          | 41.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 24                 | „            | 3,800  | —          | 31.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 25                 | „            | 3,846  | —          | 37.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 26                 | „            | 3,794  | —          | 38.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 27                 | „            | 3,815  | —          | 38.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 28                 | „            | 3,813  | —          | 37.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 29                 | „            | 3,816  | —          | 35.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 30                 | „            | 3,852  | —          | 36.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 31                 | „            | 3,767  | —          | 40.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 32                 | „            | 3,750  | —          | 33.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| November 21, 1864. |              |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 1                  | 17           | 5,495  | —          | 101.0  | —      | The gun was 9 feet right of line.<br>Weather :—Hazy, 10 a.m.<br>„ 3 p.m.<br>Wind :—Direction, N.W. by W. ; force, 2 ; 10 a.m.<br>„ S.W. by W. „ 3 ; 3 p.m.<br>Thermometer :—45 dry, 44 wet, 10 a.m.<br>49 „ 48 „ 3 p.m.<br>Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.88</td><td>49</td></tr><tr><td>29.90</td><td>51</td></tr></table> 10 a.m.<br>3 p.m.                                                | Reading. | Temperature. | 29.88 | 49 | 29.90 | 51 |
| Reading.           | Temperature. |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 29.88              | 49           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 29.90              | 51           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 2                  | „            | 5,455  | —          | 109.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 3                  | „            | 5,457  | —          | 111.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 4                  | „            | 5,475  | —          | 103.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 5                  | „            | 5,617  | —          | 114.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 6                  | „            | 5,676  | —          | 117.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 7                  | „            | 5,603  | —          | 119.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 8                  | „            | 5,616  | —          | 116.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 9                  | „            | 5,589  | —          | 108.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 10                 | „            | 5,606  | —          | 112.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 11                 | „            | 5,573  | —          | 105.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 12                 | „            | 5,487  | —          | 108.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 13                 | „            | 5,546  | —          | 113.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 14                 | „            | 5,534  | —          | 112.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 15                 | „            | 5,545  | —          | 105.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 16                 | „            | 5,568  | —          | 98.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 17                 | „            | 5,533  | —          | 99.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 18                 | „            | 5,580  | —          | 98.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 19                 | „            | 5,593  | —          | 109.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |
| 20                 | „            | 5,629  | —          | 115.0  | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |              |       |    |       |    |



RANGE AND ACCURACY—*continued*.

## SEGMENT SHELL (WEIGHTED WITH SAND).

N.B.—The figures in *Italics* are the rounds struck out by the competitors as abnormal shots.

## PARTICULARS OF SHELL AND AMMUNITION.

SHOEBURYNESS.

Weight, 68·9 lbs.

Diameter, 6·34 in.

Length, 13·88 in.

No. of segments, 98.

Bursting charge, 3 lbs. for sea service, 1 lb. for land service.

No. of studs, 15 in three rows.

Breadth of studs at top, ·45 in.

" " bottom, ·59 in.

| No. of Round. | Elevation. | Range.           | 1st Graze.  | Remarks.                                   |
|---------------|------------|------------------|-------------|--------------------------------------------|
|               |            |                  | Right.      |                                            |
|               | °          | Yards.           | Yards.      | October 11, 1864.                          |
| 1             | 2          | 1,200            | 15·4        |                                            |
| 2             | "          | 1,231            | 17·0        |                                            |
| 3             | "          | 1,237            | 16·0        |                                            |
| 4             | "          | <i>1,222</i>     | <i>21·0</i> |                                            |
| 5             | "          | 1,202            | 16·8        |                                            |
| 6             | "          | <i>1,144</i>     | <i>15·8</i> | The gun was 39 feet right of line.         |
| 7             | "          | 1,221            | 14·6        |                                            |
| 8             | "          | 1,303            | 19·4        | Weather :—Thick haze.                      |
| 9             | "          | <i>1,159</i>     | <i>17·6</i> |                                            |
| 10            | "          | 1,248            | 17·0        | Wind :—Direction, N. ; force, 2 ; 10 a.m.  |
| 11            | "          | 1,249            | 18·4        | " " " 2 ; 3 p.m.                           |
| 12            | "          | 1,307            | 18·8        |                                            |
| 13            | "          | 1,264            | 16·0        | Thermometer :—52 dry, 50 wet, 10 a.m.      |
| 14            | "          | 1,238            | 15·8        | 55 " 52 " 3 p.m.                           |
| 15            | "          | 1,218            | 17·0        |                                            |
| 16            | "          | Broke up in gun. |             | Reading. Temperature.                      |
| 17            | "          | 1,307            | 16·0        | Barometer :—30·42 54 10 a.m.               |
| 18            | "          | 1,282            | 20·0        | 30·45 68 3 p.m.                            |
| 19            | "          | 1,252            | 17·6        |                                            |
| 20            | "          | 1,287            | 15·6        |                                            |
| 21            | "          | 1,220            | 17·0        |                                            |
| 22            | "          | 1,259            | 15·6        |                                            |
| 23            | "          | 1,314            | 17·0        |                                            |
| 24            | "          | <i>1,304</i>     | <i>17·6</i> | Corresponding round, Whitworth, broke up.  |
| 25            | "          | 1,300            | 18·0        |                                            |
| 26            | "          | 1,287            | 20·0        |                                            |
| 27            | "          | 1,280            | 17·6        |                                            |
| 28            | "          | 1,234            | 16·4        |                                            |
| 29            | "          | 1,280            | 15·0        |                                            |
| 30            | "          | 1,273            | 19·6        |                                            |
| 31            | "          | 1,266            | 16·2        |                                            |
| 32            | "          | 1,284            | 18·6        |                                            |
| 33            | "          | <i>1,286</i>     | <i>19·0</i> | Ditto ditto.                               |
| 34            | "          | 1,260            | 16·0        |                                            |
| 35            | "          | 1,288            | 18·4        |                                            |
| 36            | "          | 1,287            | 18·0        |                                            |
| 37            | "          | <i>1,265</i>     | <i>16·0</i> | Corresponding round, Whitworth, not fired. |

RANGE AND ACCURACY.—SEGMENT SHELL—*continued.*

| No. of Round.     | Elevation.   | Range. | 1st Graze. | Remarks.                                                                                                              |          |              |       |    |
|-------------------|--------------|--------|------------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|                   |              |        | Right.     |                                                                                                                       |          |              |       |    |
| November 9, 1864. |              |        |            |                                                                                                                       |          |              |       |    |
|                   | °            | Yards. | Yards.     |                                                                                                                       |          |              |       |    |
| 1                 | 5            | 2,314  | 10.6       |                                                                                                                       |          |              |       |    |
| 2                 | "            | 2,294  | 5.4        |                                                                                                                       |          |              |       |    |
| 3                 | "            | 2,316  | 10.0       |                                                                                                                       |          |              |       |    |
| 4                 | "            | 2,274  | 4.2        | The gun was 9 feet right of line.                                                                                     |          |              |       |    |
| 5                 | "            | 2,325  | 6.4        |                                                                                                                       |          |              |       |    |
| 6                 | "            | 2,248  | 6.6        | Weather :—Clear.                                                                                                      |          |              |       |    |
| 7                 | "            | 2,326  | 11.0       |                                                                                                                       |          |              |       |    |
| 8                 | "            | 2,285  | 8.4        | Wind :—Direction, N.E. by E. ; force, 3 ; 10 a.m.                                                                     |          |              |       |    |
| 9                 | "            | 2,306  | 9.0        | " E. by N. ; " 4 ; 3 p.m.                                                                                             |          |              |       |    |
| 10                | "            | 2,312  | 7.8        | Thermometer :—42 dry, 41 wet, 10 a.m.                                                                                 |          |              |       |    |
| 11                | "            | 2,266  | 8.8        | 46 " 43 " 3 p.m.                                                                                                      |          |              |       |    |
| 12                | "            | 2,321  | 11.2       |                                                                                                                       |          |              |       |    |
| *13               | "            | 2,313  | 10.0       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.15</td><td>44</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.15 | 44 |
| Reading.          | Temperature. |        |            |                                                                                                                       |          |              |       |    |
| 30.15             | 44           |        |            |                                                                                                                       |          |              |       |    |
| *14               | "            | 2,158  | 8.8        | 30.12 46 3 p.m.                                                                                                       |          |              |       |    |
| *15               | "            | 2,374  | 9.6        |                                                                                                                       |          |              |       |    |
| 16                | "            | 2,256  | 9.0        | *Corresponding rounds, Whitworth, broke up.                                                                           |          |              |       |    |
| 17                | "            | 2,332  | 7.4        |                                                                                                                       |          |              |       |    |
| 18                | "            | 2,334  | 8.6        | Difficulty in loading at this round, No. 18.                                                                          |          |              |       |    |
| 19                | "            | 2,288  | 8.4        |                                                                                                                       |          |              |       |    |
| 20                | "            | 2,248  | 4.8        | Corresponding round, Whitworth, broke up.                                                                             |          |              |       |    |
| 21                | "            | 2,296  | 10.0       | Ditto ditto.                                                                                                          |          |              |       |    |
| 22                | "            | 2,304  | 8.8        |                                                                                                                       |          |              |       |    |
| 23                | "            | 2,232  | 6.6        | Ditto ditto.                                                                                                          |          |              |       |    |
| 24                | "            | 2,284  | 10.2       |                                                                                                                       |          |              |       |    |
| 25                | "            | 2,322  | 9.4        | Ditto ditto.                                                                                                          |          |              |       |    |
| October 13, 1864. |              |        |            |                                                                                                                       |          |              |       |    |
| 1                 | 8            | 3,358  | 43.0       |                                                                                                                       |          |              |       |    |
| 2                 | "            | 3,306  | 46.0       |                                                                                                                       |          |              |       |    |
| 3                 | "            | 3,475  | 47.6       |                                                                                                                       |          |              |       |    |
| 4                 | "            | 3,454  | 47.2       |                                                                                                                       |          |              |       |    |
| 5                 | "            | 3,384  | 56.2       | The gun was 39 feet right of line.                                                                                    |          |              |       |    |
| 6                 | "            | 3,334  | 51.6       |                                                                                                                       |          |              |       |    |
| *7                | "            | 3,284  | 45.4       | Weather :—Clear, 10 a.m.                                                                                              |          |              |       |    |
| 8                 | "            | 3,384  | 51.2       | Thick haze, 3 p.m.                                                                                                    |          |              |       |    |
| 9                 | "            | 3,464  | 53.4       |                                                                                                                       |          |              |       |    |
| 10                | "            | 3,456  | 54.0       | Wind :—Direction, N. by W. ; force, 3 ; 10 a.m.                                                                       |          |              |       |    |
| 11                | "            | 3,385  | 48.0       | " N.N.W. ; " 2 ; 3 p.m.                                                                                               |          |              |       |    |
| *12               | "            | 3,391  | 45.0       |                                                                                                                       |          |              |       |    |
| 13                | "            | 3,390  | 48.0       | * Corresponding rounds, Whitworth, broke up.                                                                          |          |              |       |    |
| 14                | "            | 3,402  | 50.2       |                                                                                                                       |          |              |       |    |
| *15               | "            | 3,407  | 47.0       | Thermometer :—53 dry, 51 wet, 10 a.m.                                                                                 |          |              |       |    |
| 16                | "            | 3,385  | 48.2       | 59 " 55 " 3 p.m.                                                                                                      |          |              |       |    |
| 17                | "            | 3,404  | 44.2       |                                                                                                                       |          |              |       |    |
| 18                | "            | 3,445  | 43.8       |                                                                                                                       |          |              |       |    |
| 19                | "            | 3,396  | 43.8       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.10</td><td>60</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.10 | 60 |
| Reading.          | Temperature. |        |            |                                                                                                                       |          |              |       |    |
| 30.10             | 60           |        |            |                                                                                                                       |          |              |       |    |
| 20                | "            | 3,432  | 46.8       | 30.10 60 3 p.m.                                                                                                       |          |              |       |    |
| 21                | "            | 3,380  | 47.2       |                                                                                                                       |          |              |       |    |
| 22                | "            | 3,430  | 48.2       |                                                                                                                       |          |              |       |    |
| 23                | "            | 3,415  | 45.2       |                                                                                                                       |          |              |       |    |
| 24                | "            | 3,344  | 47.6       |                                                                                                                       |          |              |       |    |
| 25                | "            | 3,441  | 42.0       |                                                                                                                       |          |              |       |    |

RANGE AND ACCURACY.—SEGMENT SHELL—*continued.*

| No. of Round.      | Elevation.   | Range.          | 1st Graze.     | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|--------------------|--------------|-----------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|                    |              |                 | Right.         |                                                                                                                                                         |          |              |       |    |       |    |
| November 9, 1864.  |              |                 |                |                                                                                                                                                         |          |              |       |    |       |    |
| 1                  | 11           | Yards.<br>4,160 | Yards.<br>52.0 |                                                                                                                                                         |          |              |       |    |       |    |
| 2                  | "            | 4,002           | 45.4           |                                                                                                                                                         |          |              |       |    |       |    |
| 3                  | "            | 3,999           | 39.4           |                                                                                                                                                         |          |              |       |    |       |    |
| 4                  | "            | 4,048           | 38.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 5                  | "            | 4,058           | 47.8           |                                                                                                                                                         |          |              |       |    |       |    |
| 6                  | "            | —               | —              | Broke up in gun.                                                                                                                                        |          |              |       |    |       |    |
| 7                  | "            | 4,058           | 51.6           |                                                                                                                                                         |          |              |       |    |       |    |
| 8                  | "            | 4,114           | 49.2           |                                                                                                                                                         |          |              |       |    |       |    |
| 9                  | "            | 4,064           | 44.6           |                                                                                                                                                         |          |              |       |    |       |    |
| 10                 | "            | 4,036           | 52.8           |                                                                                                                                                         |          |              |       |    |       |    |
| 11                 | "            | 4,000           | 48.0           | The gun was 9 feet left of line.                                                                                                                        |          |              |       |    |       |    |
| 12                 | "            | 4,026           | 50.6           |                                                                                                                                                         |          |              |       |    |       |    |
| 13                 | "            | 4,030           | 46.2           | Weather :—Clear.                                                                                                                                        |          |              |       |    |       |    |
| 14                 | "            | 4,013           | 51.6           |                                                                                                                                                         |          |              |       |    |       |    |
| 15                 | "            | 4,100           | 50.0           | Wind :—Direction, N.E. by E.; force, 3 ; 10 a.m.                                                                                                        |          |              |       |    |       |    |
| 16                 | "            | 4,137           | 46.0           | " E. by N. " 4 ; 3 p.m.                                                                                                                                 |          |              |       |    |       |    |
| 17                 | "            | 4,131           | 50.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 18                 | "            | 4,141           | 50.4           | Thermometer :—42 dry, 41 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 19                 | "            | 3,975           | 52.0           | 46 " 43 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 20                 | "            | 4,016           | 47.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 21                 | "            | 4,096           | 46.0           | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.15</td><td>44</td></tr><tr><td>30.12</td><td>46</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.15 | 44 | 30.12 | 46 |
| Reading.           | Temperature. |                 |                |                                                                                                                                                         |          |              |       |    |       |    |
| 30.15              | 44           |                 |                |                                                                                                                                                         |          |              |       |    |       |    |
| 30.12              | 46           |                 |                |                                                                                                                                                         |          |              |       |    |       |    |
| 22                 | "            | 4,041           | 43.6           | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 23                 | "            | 4,104           | 48.8           |                                                                                                                                                         |          |              |       |    |       |    |
| 24                 | "            | 4,042           | 49.2           |                                                                                                                                                         |          |              |       |    |       |    |
| 25                 | "            | 4,116           | 52.6           |                                                                                                                                                         |          |              |       |    |       |    |
| 26                 | "            | 3,958           | 46.6           |                                                                                                                                                         |          |              |       |    |       |    |
| 27                 | "            | 3,992           | 53.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 28                 | "            | 4,095           | 52.4           | Corresponding round, Whitworth, broke up.                                                                                                               |          |              |       |    |       |    |
| 29                 | "            | 4,065           | 53.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 30                 | "            | 4,107           | 43.6           |                                                                                                                                                         |          |              |       |    |       |    |
| 31                 | "            | 4,079           | 59.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 32                 | "            | 4,144           | 50.4           |                                                                                                                                                         |          |              |       |    |       |    |
| 33                 | "            | 4,108           | 54.6           |                                                                                                                                                         |          |              |       |    |       |    |
| 34                 | "            | 4,144           | 51.4           | Ditto ditto.                                                                                                                                            |          |              |       |    |       |    |
| 35                 | "            | 4,110           | 53.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 36                 | "            | 4,070           | 47.8           |                                                                                                                                                         |          |              |       |    |       |    |
| 37                 | "            | 4,178           | 60.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 38                 | "            | 4,045           | 49.2           |                                                                                                                                                         |          |              |       |    |       |    |
| 39                 | "            | 4,089           | 50.6           |                                                                                                                                                         |          |              |       |    |       |    |
| 40                 | "            | 4,078           | 49.0           | Ditto ditto.                                                                                                                                            |          |              |       |    |       |    |
| 41                 | "            | 4,025           | 38.6           |                                                                                                                                                         |          |              |       |    |       |    |
| 42                 | "            | 4,119           | 53.4           |                                                                                                                                                         |          |              |       |    |       |    |
| 43                 | "            | 4,091           | 51.2           |                                                                                                                                                         |          |              |       |    |       |    |
| 44                 | "            | 4,111           | 53.4           | Ditto ditto.                                                                                                                                            |          |              |       |    |       |    |
| November 18, 1864. |              |                 |                |                                                                                                                                                         |          |              |       |    |       |    |
| 1                  | 19           | 6,659           | 74.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 2                  | "            | 6,543           | 62.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 3                  | "            | 6,743           | 70.0           | The gun was 9 feet right of line.                                                                                                                       |          |              |       |    |       |    |
| 4                  | "            | 6,764           | 89.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 5                  | "            | 6,640           | 90.0           | Corresponding round, Whitworth, not seen.                                                                                                               |          |              |       |    |       |    |
| 6                  | "            | 6,745           | 85.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 7                  | "            | 6,532           | 52.0           | Weather :—Clear, 10 a.m.                                                                                                                                |          |              |       |    |       |    |
| 8                  | "            | 6,407           | 54.0           | Slight haze, 3 p.m.                                                                                                                                     |          |              |       |    |       |    |
| 9                  | "            | 6,503           | 52.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 10                 | "            | 6,477           | 51.0           | Wind :—Direction, W. ; force, 7 ; 10 a.m.                                                                                                               |          |              |       |    |       |    |
| 11                 | "            | 6,478           | 44.0           | " N.W. by N. ; force, 6 ; 3 p.m.                                                                                                                        |          |              |       |    |       |    |
| 12                 | "            | 6,618           | 94.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 13                 | "            | Lost.           | —              | Thermometer :—51 dry, 49 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 14                 | "            | 6,559           | 52.0           | 51 " 50 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 15                 | "            | 6,567           | 36.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 16                 | "            | 6,574           | 65.0           | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.30</td><td>51</td></tr><tr><td>29.30</td><td>51</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.30 | 51 | 29.30 | 51 |
| Reading.           | Temperature. |                 |                |                                                                                                                                                         |          |              |       |    |       |    |
| 29.30              | 51           |                 |                |                                                                                                                                                         |          |              |       |    |       |    |
| 29.30              | 51           |                 |                |                                                                                                                                                         |          |              |       |    |       |    |
| 17                 | "            | 6,753           | 66.0           | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 18                 | "            | Lost.           | —              |                                                                                                                                                         |          |              |       |    |       |    |
| 19                 | "            | 6,701           | 60.0           |                                                                                                                                                         |          |              |       |    |       |    |
| 20                 | "            | 6,802           | 64.0           |                                                                                                                                                         |          |              |       |    |       |    |

## SEGMENT SHELL.

December 20, 1864.

RANGE, 800 yards.

The shells were fired through screens 4" in thickness so as to burst the shell 100 yards in front of the 1st line of targets.

Three lines of 6 targets each, 10 yards apart.  
Bursting charge of shell, 1 lb.

|                                     |           | Through. | Lodged. | Struck. |
|-------------------------------------|-----------|----------|---------|---------|
| Struck 15 feet<br>above the ground. | 1st line. |          |         |         |
|                                     | 1 target  | 1        | 0       | 0       |
|                                     | 2 "       | 0        | 0       | 0       |
|                                     | 3 "       | 0        | 2       | 1       |
|                                     | 4 "       | 0        | 0       | 0       |
|                                     | 5 "       | 0        | 0       | 0       |
|                                     | 6 "       | 0        | 0       | 0       |
|                                     | 2nd line. |          |         |         |
|                                     | 1 target  | 0        | 0       | 0       |
|                                     | 2 "       | 0        | 0       | 0       |
|                                     | 3 "       | 0        | 0       | 0       |
|                                     | 4 "       | 0        | 0       | 0       |
|                                     | 5 "       | 0        | 0       | 0       |
|                                     | 6 "       | 1        | 0       | 0       |
|                                     | 3rd line. |          |         |         |
|                                     | 1 target  | 0        | 0       | 0       |
|                                     | 2 "       | 0        | 0       | 0       |
|                                     | 3 "       | 1        | 0       | 0       |
|                                     | 4 "       | 1        | 3       | 1       |
|                                     | 5 "       | 0        | 0       | 2       |
|                                     | 6 "       | 0        | 0       | 0       |
| Struck 9 feet above<br>the ground.  | 1st line. |          |         |         |
|                                     | 1 target  | 0        | 0       | 1       |
|                                     | 2 "       | 1        | 0       | 0       |
|                                     | 3 "       | 2        | 1       | 0       |
|                                     | 4 "       | 1        | 0       | 0       |
|                                     | 5 "       | 0        | 1       | 0       |
|                                     | 6 "       | 0        | 0       | 0       |
|                                     | 2nd line. |          |         |         |
|                                     | 1 target  | 0        | 0       | 0       |
|                                     | 2 "       | 0        | 1       | 0       |
|                                     | 3 "       | 1        | 1       | 1       |
|                                     | 4 "       | 3        | 0       | 0       |
|                                     | 5 "       | 0        | 0       | 1       |
|                                     | 6 "       | 0        | 0       | 0       |
|                                     | 3rd line. |          |         |         |
|                                     | 1 target  | 0        | 0       | 0       |
|                                     | 2 "       | 3        | 0       | 0       |
|                                     | 3 "       | 1        | 1       | 2       |
|                                     | 4 "       | 3        | 0       | 0       |
|                                     | 5 "       | 0        | 0       | 0       |
|                                     | 6 "       | 0        | 0       | 0       |
| Struck 15 feet<br>above the ground. | 1st line. |          |         |         |
|                                     | 1 target  | 0        | 0       | 0       |
|                                     | 2 "       | 0        | 0       | 0       |
|                                     | 3 "       | 0        | 2       | 2       |
|                                     | 4 "       | 1        | 1       | 0       |
|                                     | 5 "       | 1        | 1       | 0       |
|                                     | 6 "       | 0        | 0       | 0       |
|                                     | 2nd line. |          |         |         |
|                                     | 1 target  | 0        | 0       | 0       |
|                                     | 2 "       | 0        | 1       | 0       |
|                                     | 3 "       | 0        | 0       | 0       |
|                                     | 4 "       | 1        | 0       | 0       |
|                                     | 5 "       | 0        | 0       | 0       |
|                                     | 6 "       | 0        | 0       | 1       |
|                                     | 3rd line. |          |         |         |
|                                     | 1 target  | 0        | 0       | 0       |
|                                     | 2 "       | 0        | 0       | 0       |
|                                     | 3 "       | 0        | 1       | 0       |
|                                     | 4 "       | 1        | 0       | 1       |
|                                     | 5 "       | 0        | 0       | 0       |
|                                     | 6 "       | 0        | 0       | 0       |

December 20, 1864.

The screen placed so as burst the shell 50 yards in front of the targets.

|                                      |           | Through. | Lodged. | Struck. |
|--------------------------------------|-----------|----------|---------|---------|
| Struck 8 inches<br>above the ground. | 1st line. |          |         |         |
|                                      | 1 target  | 1        | 0       | 1       |
|                                      | 2 "       | 1        | 2       | 0       |
|                                      | 3 "       | 6        | 0       | 3       |
|                                      | 4 "       | 9        | 0       | 2       |
|                                      | 5 "       | 8        | 0       | 1       |
|                                      | 6 "       | 5        | 0       | 1       |
|                                      | 2nd line. |          |         |         |
|                                      | 1 target  | 0        | 1       | 0       |
|                                      | 2 "       | 1        | 0       | 0       |
|                                      | 3 "       | 3        | 0       | 0       |
|                                      | 4 "       | 10       | 1       | 3       |
|                                      | 5 "       | 7        | 3       | 3       |
|                                      | 6 "       | 3        | 1       | 2       |
|                                      | 3rd line. |          |         |         |
|                                      | 1 target  | 0        | 0       | 0       |
|                                      | 2 "       | 0        | 0       | 0       |
|                                      | 3 "       | 2        | 0       | 0       |
|                                      | 4 "       | 6        | 0       | 2       |
|                                      | 5 "       | 3        | 1       | 0       |
|                                      | 6 "       | 2        | 0       | 0       |
| Struck 4 feet above<br>the ground.   | 1st line. |          |         |         |
|                                      | 1 target  | 6        | 2       | 0       |
|                                      | 2 "       | 10       | 4       | 1       |
|                                      | 3 "       | 5        | 2       | 0       |
|                                      | 4 "       | 5        | 2       | 2       |
|                                      | 5 "       | 0        | 0       | 0       |
|                                      | 6 "       | 0        | 0       | 0       |
|                                      | 2nd line. |          |         |         |
|                                      | 1 target  | 5        | 3       | 0       |
|                                      | 2 "       | 4        | 0       | 1       |
|                                      | 3 "       | 2        | 0       | 0       |
|                                      | 4 "       | 0        | 0       | 1       |
|                                      | 5 "       | 2        | 2       | 0       |
|                                      | 6 "       | 0        | 0       | 0       |
|                                      | 3rd line. |          |         |         |
|                                      | 1 target  | 0        | 1       | 0       |
|                                      | 2 "       | 0        | 0       | 0       |
|                                      | 3 "       | 0        | 1       | 0       |
|                                      | 4 "       | 1        | 1       | 0       |
|                                      | 5 "       | 1        | 0       | 0       |
|                                      | 6 "       | 1        | 0       | 0       |
| Struck 9 feet above<br>the ground.   | 1st line. |          |         |         |
|                                      | 1 target  | 7        | 0       | 0       |
|                                      | 2 "       | 3        | 1       | 0       |
|                                      | 3 "       | 4        | 3       | 1       |
|                                      | 4 "       | 3        | 0       | 0       |
|                                      | 5 "       | 0        | 1       | 0       |
|                                      | 6 "       | 4        | 2       | 3       |
|                                      | 2nd line. |          |         |         |
|                                      | 1 target  | 0        | 0       | 0       |
|                                      | 2 "       | 0        | 0       | 2       |
|                                      | 3 "       | 2        | 0       | 0       |
|                                      | 4 "       | 3        | 1       | 2       |
|                                      | 5 "       | 0        | 1       | 0       |
|                                      | 6 "       | 0        | 1       | 0       |
|                                      | 3rd line. |          |         |         |
|                                      | 1 target  | 0        | 0       | 0       |
|                                      | 2 "       | 0        | 0       | 0       |
|                                      | 3 "       | 0        | 0       | 0       |
|                                      | 4 "       | 1        | 1       | 0       |
|                                      | 5 "       | 1        | 1       | 0       |
|                                      | 6 "       | 0        | 0       | 0       |

## SEGMENT SHELL—continued.

December 20, 1864.

The screen was placed so as to burst the shell 10 yards in front of the targets.

| —                               | —         | Through. | Lodged. | Struck. |
|---------------------------------|-----------|----------|---------|---------|
| Struck 7 feet above the ground. | 1st line. |          |         |         |
|                                 | 1 target  | 0        | 0       | 0       |
|                                 | 2 "       | 2        | 0       | 1       |
|                                 | 3 "       | 75       | 0       | 2       |
|                                 | 4 "       | 4        | 0       | 2       |
|                                 | 5 "       | 0        | 0       | 1       |
|                                 | 6 "       | 0        | 0       | 1       |
|                                 | 2nd line. |          |         |         |
|                                 | 1 target  | 0        | 0       | 0       |
|                                 | 2 "       | 0        | 0       | 0       |
|                                 | 3 "       | 39       | 3       | 2       |
|                                 | 4 "       | 13       | 1       | 9       |
|                                 | 5 "       | 27       | 3       | 9       |
|                                 | 6 "       | 0        | 0       | 0       |
|                                 | 3rd line. |          |         |         |
|                                 | 1 target  | 0        | 0       | 0       |
|                                 | 2 "       | 9        | 2       | 0       |
|                                 | 3 "       | 15       | 4       | 3       |
|                                 | 4 "       | 13       | 0       | 0       |
|                                 | 5 "       | 7        | 3       | 2       |
|                                 | 6 "       | 4        | 0       | 3       |

| —                                              | —         | Through. | Lodged. | Struck. |
|------------------------------------------------|-----------|----------|---------|---------|
| Struck 3 feet above the ground.                | 1st line. |          |         |         |
|                                                | 1 target  | 0        | 0       | 0       |
|                                                | 2 "       | 0        | 0       | 0       |
|                                                | 3 "       | 4        | 1       | 0       |
|                                                | 4 "       | 2        | 0       | 0       |
|                                                | 5 "       | 0        | 0       | 0       |
|                                                | 6 "       | 0        | 0       | 0       |
|                                                | 2nd line. |          |         |         |
|                                                | 1 target  | 0        | 0       | 1       |
|                                                | 2 "       | 0        | 0       | 1       |
|                                                | 3 "       | 8        | 2       | 1       |
|                                                | 4 "       | 28       | 1       | 1       |
|                                                | 5 "       | 30       | 3       | 7       |
|                                                | 6 "       | 0        | 0       | 0       |
|                                                | 3rd line. |          |         |         |
|                                                | 1 target  | 0        | 0       | 0       |
|                                                | 2 "       | 2        | 1       | 2       |
|                                                | 3 "       | 11       | 1       | 0       |
|                                                | 4 "       | 14       | 8       | 6       |
|                                                | 5 "       | 3        | 4       | 2       |
|                                                | 6 "       | 10       | 4       | 5       |
| A large piece of No. 3 and 4 targets cut away. |           |          |         |         |

| —                                    | —         | Through. | Lodged. | Struck. |
|--------------------------------------|-----------|----------|---------|---------|
| Struck 8½ feet above the ground.     | 1st line. |          |         |         |
|                                      | 1 target  | 0        | 0       | 0       |
|                                      | 2 "       | 0        | 0       | 0       |
|                                      | 3 "       | 15       | 0       | 0       |
|                                      | 4 "       | 1        | 0       | 0       |
|                                      | 5 "       | 0        | 0       | 0       |
|                                      | 6 "       | 0        | 0       | 0       |
|                                      | 2nd line. |          |         |         |
|                                      | 1 target  | 0        | 0       | 0       |
|                                      | 2 "       | 0        | 0       | 0       |
|                                      | 3 "       | 23       | 0       | 1       |
|                                      | 4 "       | 16       | 0       | 1       |
|                                      | 5 "       | 10       | 0       | 1       |
|                                      | 6 "       | 0        | 0       | 0       |
|                                      | 3rd line. |          |         |         |
|                                      | 1 target  | 0        | 0       | 0       |
|                                      | 2 "       | 2        | 0       | 2       |
|                                      | 3 "       | 14       | 2       | 1       |
|                                      | 4 "       | 5        | 1       | 0       |
|                                      | 5 "       | 6        | 6       | 5       |
|                                      | 6 "       | 1        | 0       | 0       |
| One-fourth of No. 3 target cut away. |           |          |         |         |



## SEGMENT SHELL—continued.

February 2, 1865.

RANGE, 800 yards.

Firing carried on against three lines of 2-inch targets 9 feet square, six targets in each line; 10 yards interval between the lines.

|  |           | Through. | Lodged. | Struck. | Struck 85 yards short. | Struck 115 yards short. | Struck 111 yards short. | Struck 100 yards short. |
|--|-----------|----------|---------|---------|------------------------|-------------------------|-------------------------|-------------------------|
|  | 1st line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 9        | 0       | 1       |                        |                         |                         |                         |
|  | 2 "       | 4        | 0       | 0       |                        |                         |                         |                         |
|  | 3 "       | 4        | 0       | 0       |                        |                         |                         |                         |
|  | 4 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 5 "       | 6        | 0       | 0       |                        |                         |                         |                         |
|  | 6 "       | 7        | 1       | 0       |                        |                         |                         |                         |
|  | 2nd line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 3        | 4       | 0       |                        |                         |                         |                         |
|  | 2 "       | 1        | 1       | 0       |                        |                         |                         |                         |
|  | 3 "       | 0        | 0       | 1       |                        |                         |                         |                         |
|  | 4 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 5 "       | 1        | 1       | 1       |                        |                         |                         |                         |
|  | 6 "       | 1        | 0       | 0       |                        |                         |                         |                         |
|  | 3rd line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 2 "       | 1        | 1       | 0       |                        |                         |                         |                         |
|  | 3 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 4 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 5 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 6 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 1st line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 3        | 1       | 0       |                        |                         |                         |                         |
|  | 2 "       | 2        | 1       | 0       |                        |                         |                         |                         |
|  | 3 "       | 2        | 1       | 0       |                        |                         |                         |                         |
|  | 4 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 5 "       | 1        | 0       | 0       |                        |                         |                         |                         |
|  | 6 "       | 3        | 0       | 0       |                        |                         |                         |                         |
|  | 2nd line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 2 "       | 0        | 3       | 0       |                        |                         |                         |                         |
|  | 3 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 4 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 5 "       | 0        | 0       | 1       |                        |                         |                         |                         |
|  | 6 "       | 0        | 2       | 1       |                        |                         |                         |                         |
|  | 3rd line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 2 "       | 0        | 0       | 1       |                        |                         |                         |                         |
|  | 3 "       | } Nil.   | Nil.    | Nil.    |                        |                         |                         |                         |
|  | 4 "       |          |         |         |                        |                         |                         |                         |
|  | 5 "       |          |         |         |                        |                         |                         |                         |
|  | 6 "       |          |         |         |                        |                         |                         |                         |
|  | 1st line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 2        | 1       | 0       |                        |                         |                         |                         |
|  | 2 "       | 3        | 1       | 0       |                        |                         |                         |                         |
|  | 3 "       | 2        | 0       | 1       |                        |                         |                         |                         |
|  | 4 "       | 0        | 1       | 0       |                        |                         |                         |                         |
|  | 5 "       | 1        | 1       | 0       |                        |                         |                         |                         |
|  | 6 "       | 1        | 2       | 0       |                        |                         |                         |                         |
|  | 2nd line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 0        | 0       | 1       |                        |                         |                         |                         |
|  | 2 "       | 0        | 0       | 1       |                        |                         |                         |                         |
|  | 3 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 4 "       | 0        | 1       | 1       |                        |                         |                         |                         |
|  | 5 "       | 0        | 1       | 0       |                        |                         |                         |                         |
|  | 6 "       | 0        | 1       | 0       |                        |                         |                         |                         |
|  | 3rd line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 2 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 3 "       | 0        | 1       | 0       |                        |                         |                         |                         |
|  | 4 "       | } Nil.   | Nil.    | Nil.    |                        |                         |                         |                         |
|  | 5 "       |          |         |         |                        |                         |                         |                         |
|  | 6 "       |          |         |         |                        |                         |                         |                         |
|  | 1st line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 2        | 1       | 0       |                        |                         |                         |                         |
|  | 2 "       | 3        | 1       | 0       |                        |                         |                         |                         |
|  | 3 "       | 2        | 0       | 1       |                        |                         |                         |                         |
|  | 4 "       | 0        | 1       | 0       |                        |                         |                         |                         |
|  | 5 "       | 1        | 1       | 0       |                        |                         |                         |                         |
|  | 6 "       | 1        | 2       | 0       |                        |                         |                         |                         |
|  | 2nd line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 0        | 0       | 1       |                        |                         |                         |                         |
|  | 2 "       | 0        | 0       | 1       |                        |                         |                         |                         |
|  | 3 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 4 "       | 0        | 1       | 1       |                        |                         |                         |                         |
|  | 5 "       | 0        | 1       | 0       |                        |                         |                         |                         |
|  | 6 "       | 0        | 1       | 0       |                        |                         |                         |                         |
|  | 3rd line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 2 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 3 "       | 0        | 1       | 0       |                        |                         |                         |                         |
|  | 4 "       | } Nil.   | Nil.    | Nil.    |                        |                         |                         |                         |
|  | 5 "       |          |         |         |                        |                         |                         |                         |
|  | 6 "       |          |         |         |                        |                         |                         |                         |
|  | 1st line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 2        | 1       | 0       |                        |                         |                         |                         |
|  | 2 "       | 3        | 1       | 0       |                        |                         |                         |                         |
|  | 3 "       | 2        | 0       | 1       |                        |                         |                         |                         |
|  | 4 "       | 0        | 1       | 0       |                        |                         |                         |                         |
|  | 5 "       | 1        | 1       | 0       |                        |                         |                         |                         |
|  | 6 "       | 1        | 2       | 0       |                        |                         |                         |                         |
|  | 2nd line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 0        | 0       | 1       |                        |                         |                         |                         |
|  | 2 "       | 0        | 0       | 1       |                        |                         |                         |                         |
|  | 3 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 4 "       | 0        | 1       | 1       |                        |                         |                         |                         |
|  | 5 "       | 0        | 1       | 0       |                        |                         |                         |                         |
|  | 6 "       | 0        | 1       | 0       |                        |                         |                         |                         |
|  | 3rd line. |          |         |         |                        |                         |                         |                         |
|  | 1 target  | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 2 "       | 0        | 0       | 0       |                        |                         |                         |                         |
|  | 3 "       | 0        | 1       | 0       |                        |                         |                         |                         |
|  | 4 "       | } Nil.   | Nil.    | Nil.    |                        |                         |                         |                         |
|  | 5 "       |          |         |         |                        |                         |                         |                         |
|  | 6 "       |          |         |         |                        |                         |                         |                         |



## SEGMENT SHELL—continued.

|                           |           | Through. | Lodged. | Struck. |                           |           | Through. | Lodged. | Struck. |
|---------------------------|-----------|----------|---------|---------|---------------------------|-----------|----------|---------|---------|
| Struck 42 yards<br>short. | 1st line. |          |         |         | Struck 67 yards<br>short. | 1st line. |          |         |         |
|                           | 1 target  | 16       | 0       | 0       |                           | 1 target  | 5        | 1       | 0       |
|                           | 2 "       | 3        | 2       | 0       |                           | 2 "       | 7        | 0       | 0       |
|                           | 3 "       | 4        | 0       | 0       |                           | 3 "       | 5        | 1       | 0       |
|                           | 4 "       | 8        | 0       | 0       |                           | 4 "       | 2        | 0       | 0       |
|                           | 5 "       | 8        | 0       | 1       |                           | 5 "       | 2        | 1       | 0       |
|                           | 6 "       | 2        | 0       | 0       |                           | 6 "       | 3        | 1       | 0       |
|                           | 2nd line. |          |         |         |                           | 2nd line. |          |         |         |
|                           | 1 target  | 4        | 0       | 0       |                           | 1 target  | 2        | 2       | 3       |
|                           | 2 "       | 0        | 0       | 0       |                           | 2 "       | 4        | 3       | 2       |
|                           | 3 "       | 1        | 0       | 0       |                           | 3 "       | 2        | 2       | 3       |
|                           | 4 "       | 1        | 1       | 2       |                           | 4 "       | 0        | 2       | 0       |
|                           | 5 "       | 4        | 0       | 0       |                           | 5 "       | 1        | 1       | 0       |
|                           | 6 "       | 5        | 0       | 0       |                           | 6 "       | 3        | 1       | 1       |
|                           | 3rd line. |          |         |         |                           | 3rd line. |          |         |         |
|                           | 1 target  | 1        | 2       | 2       |                           | 1 target  | 0        | 0       | 0       |
|                           | 2 "       | 0        | 0       | 0       |                           | 2 "       | 0        | 0       | 0       |
|                           | 3 "       | 0        | 0       | 0       |                           | 3 "       | 0        | 0       | 1       |
| 4 "                       | } Nil.    | Nil.     | Nil.    | 4 "     | 0                         | 0         | 0        |         |         |
| 5 "                       |           |          |         | 0       | 0                         | 1         |          |         |         |
| 6 "                       |           |          |         | 1       | 0                         | 1         |          |         |         |
| Struck 98 yards<br>short. | 1st line. |          |         |         | Struck 87 yards<br>short. | 1st line. |          |         |         |
|                           | 1 target  | 1        | 0       | 0       |                           | 1 target  | 10       | 0       | 0       |
|                           | 2 "       | 1        | 0       | 0       |                           | 2 "       | 3        | 0       | 1       |
|                           | 3 "       | 0        | 1       | 1       |                           | 3 "       | 3        | 1       | 1       |
|                           | 4 "       | 1        | 0       | 1       |                           | 4 "       | 5        | 1       | 0       |
|                           | 5 "       | 3        | 1       | 0       |                           | 5 "       | 3        | 0       | 1       |
|                           | 6 "       | 3        | 0       | 0       |                           | 6 "       | 6        | 1       | 0       |
|                           | 2nd line. |          |         |         |                           | 2nd line. |          |         |         |
|                           | 1 target  | 2        | 0       | 0       |                           | 1 target  | 1        | 0       | 0       |
|                           | 2 "       | 0        | 1       | 0       |                           | 2 "       | 0        | 0       | 0       |
|                           | 3 "       | 1        | 0       | 0       |                           | 3 "       | 0        | 1       | 1       |
|                           | 4 "       | 0        | 1       | 0       |                           | 4 "       | 1        | 0       | 2       |
|                           | 5 "       | 1        | 1       | 0       |                           | 5 "       | 2        | 0       | 0       |
|                           | 6 "       | 0        | 1       | 0       |                           | 6 "       | 1        | 0       | 1       |
|                           | 3rd line. |          |         |         |                           | 3rd line. |          |         |         |
|                           | 1 target  | } Nil.   | Nil.    | Nil.    |                           | 1 target  | 0        | 0       | 1       |
|                           | 2 "       |          |         |         |                           | 1         | 0        | 0       |         |
|                           | 3 "       |          |         |         |                           | 0         | 0        | 0       |         |
| 4 "                       | 0         |          |         |         | 0                         | 0         |          |         |         |
| 5 "                       | 0         |          |         |         | 0                         | 0         |          |         |         |
| 6 "                       | 0         |          |         |         | 0                         | 1         |          |         |         |
| Struck 80 yards<br>short. | 1st line. |          |         |         | Struck 28 yards<br>short. | 1st line. |          |         |         |
|                           | 1 target  | 0        | 0       | 0       |                           | 1 target  | 12       | 1       | 1       |
|                           | 2 "       | 2        | 1       | 0       |                           | 2 "       | 9        | 1       | 1       |
|                           | 3 "       | 3        | 1       | 0       |                           | 3 "       | 20       | 0       | 3       |
|                           | 4 "       | 5        | 2       | 0       |                           | 4 "       | 16       | 0       | 4       |
|                           | 5 "       | 0        | 0       | 1       |                           | 5 "       | 4        | 1       | 5       |
|                           | 6 "       | 0        | 1       | 1       |                           | 6 "       | 0        | 0       | 0       |
|                           | 2nd line. |          |         |         |                           | 2nd line. |          |         |         |
|                           | 1 target  | 0        | 0       | 0       |                           | 1 target  | 3        | 2       | 0       |
|                           | 2 "       | 2        | 0       | 0       |                           | 2 "       | 3        | 1       | 1       |
|                           | 3 "       | 0        | 2       | 0       |                           | 3 "       | 9        | 0       | 0       |
|                           | 4 "       | 0        | 0       | 0       |                           | 4 "       | 5        | 3       | 1       |
|                           | 5 "       | 1        | 0       | 0       |                           | 5 "       | 7        | 1       | 1       |
|                           | 6 "       | 0        | 0       | 0       |                           | 6 "       | 0        | 0       | 1       |
|                           | 3rd line. |          |         |         |                           | 3rd line. |          |         |         |
|                           | 1 target  | 0        | 0       | 0       |                           | 1 target  | 0        | 0       | 0       |
|                           | 2 "       | 0        | 0       | 0       |                           | 2 "       | 0        | 0       | 4       |
|                           | 3 "       | 1        | 0       | 0       |                           | 3 "       | 0        | 1       | 1       |
| 4 "                       | 0         | 0        | 0       | 4 "     | 1                         | 0         | 2        |         |         |
| 5 "                       | } Nil.    | Nil.     | Nil.    | 5 "     | 0                         | 3         | 0        |         |         |
| 6 "                       |           |          |         | 2       | 0                         | 1         |          |         |         |

## SEGMENT SHELL—continued.

|                           |           | Through. | Lodged. | Struck. |                                                                               |           | Through. | Lodged. | Struck. |
|---------------------------|-----------|----------|---------|---------|-------------------------------------------------------------------------------|-----------|----------|---------|---------|
| Struck 35 yards<br>short. | 1st line. |          |         |         | Struck 16 yards<br>short—cont.                                                | 3rd line. |          |         |         |
|                           | 1 target  | 5        | 1       | 0       |                                                                               | 1 target  | 2        | 3       | 0       |
|                           | 2 "       | 7        | 2       | 1       |                                                                               | 2 "       | 4        | 1       | 2       |
|                           | 3 "       | 9        | 3       | 1       |                                                                               | 3 "       | 1        | 1       | 1       |
|                           | 4 "       | 3        | 1       | 0       |                                                                               | 4 "       | 0        | 0       | 0       |
|                           | 5 "       | 3        | 0       | 0       |                                                                               | 5 "       | 0        | 1       | 0       |
|                           | 6 "       | 6        | 0       | 0       |                                                                               | 6 "       | 0        | 0       | 0       |
|                           | 2nd line. |          |         |         |                                                                               | 1st line. |          |         |         |
|                           | 1 target  | 8        | 2       | 1       |                                                                               | 1 target  | 2        | 0       | 0       |
|                           | 2 "       | 4        | 0       | 0       |                                                                               | 2 "       | 12       | 2       | 0       |
|                           | 3 "       | 2        | 0       | 1       |                                                                               | 3 "       | 15       | 2       | 1       |
|                           | 4 "       | 0        | 1       | 0       |                                                                               | 4 "       | 19       | 0       | 0       |
|                           | 5 "       | 1        | 0       | 1       |                                                                               | 5 "       | 16       | 1       | 1       |
|                           | 6 "       | 1        | 0       | 0       |                                                                               | 6 "       | 2        | 0       | 0       |
|                           | 3rd line. |          |         |         |                                                                               | 2nd line. |          |         |         |
|                           | 1 target  | 0        | 0       | 1       |                                                                               | 1 target  | 2        | 0       | 0       |
|                           | 2 "       | 0        | 0       | 3       |                                                                               | 2 "       | 9        | 2       | 0       |
|                           | 3 "       | 1        | 0       | 0       |                                                                               | 3 "       | 7        | 1       | 4       |
|                           | 4 "       | 0        | 0       | 0       |                                                                               | 4 "       | 9        | 5       | 1       |
|                           | 5 "       | 0        | 0       | 2       |                                                                               | 5 "       | 8        | 1       | 1       |
|                           | 6 "       | 0        | 0       | 1       |                                                                               | 6 "       | 3        | 1       | 1       |
| Struck 15 yards<br>short. | 1st line. |          |         |         | Struck 12 yards<br>short.                                                     | 3rd line. |          |         |         |
|                           | 1 target  | 1        | 1       | 0       |                                                                               | 1 target  | 1        | 0       | 0       |
|                           | 2 "       | 9        | 0       | 1       |                                                                               | 2 "       | 6        | 0       | 2       |
|                           | 3 "       | 30       | 2       | 2       |                                                                               | 3 "       | 3        | 1       | 2       |
|                           | 4 "       | 28       | 0       | 0       |                                                                               | 4 "       | 2        | 2       | 6       |
|                           | 5 "       | 9        | 1       | 0       |                                                                               | 5 "       | 2        | 3       | 2       |
|                           | 6 "       | 1        | 0       | 0       |                                                                               | 6 "       | 0        | 1       | 0       |
|                           | 2nd line. |          |         |         |                                                                               | 1st line. |          |         |         |
|                           | 1 target  | 4        | 1       | 2       |                                                                               | 1 target  | 0        | 0       | 0       |
|                           | 2 "       | 13       | 0       | 0       |                                                                               | 2 "       | 0        | 2       | 1       |
|                           | 3 "       | 13       | 0       | 1       |                                                                               | 3 "       | 4        | 1       | 2       |
|                           | 4 "       | 13       | 2       | 1       |                                                                               | 4 "       | } Nil.   | Nil.    | Nil.    |
|                           | 5 "       | 6        | 0       | 0       |                                                                               | 5 "       |          |         |         |
|                           | 6 "       | 2        | 0       | 0       |                                                                               | 6 "       |          |         |         |
|                           | 3rd line. |          |         |         |                                                                               | 2nd line. |          |         |         |
|                           | 1 target  | 0        | 1       | 1       |                                                                               | 1 target  | 0        | 0       | 0       |
|                           | 2 "       | 1        | 1       | 1       |                                                                               | 2 "       | 11       | 0       | 0       |
|                           | 3 "       | 1        | 2       | 2       |                                                                               | 3 "       | 37       | 0       | 0       |
|                           | 4 "       | 1        | 5       | 5       |                                                                               | 4 "       | 34       | 1       | 2       |
|                           | 5 "       | 1        | 1       | 1       |                                                                               | 5 "       | 1        | 1       | 2       |
|                           | 6 "       | 0        | 0       | 0       |                                                                               | 6 "       | 0        | 1       | 0       |
| Struck 16 yards<br>short. | 1st line. |          |         |         | Targets so de-<br>stroyed that<br>accurate count-<br>ing was impos-<br>sible. | 3rd line. |          |         |         |
|                           | 1 target  | 4        | 0       | 1       |                                                                               | 1 target  | 0        | 0       | 0       |
|                           | 2 "       | 22       | 2       | 2       |                                                                               | 2 "       | 14       | 3       | 2       |
|                           | 3 "       | 8        | 1       | 1       |                                                                               | 3 "       | 24       | 6       | 0       |
|                           | 4 "       | 1        | 2       | 1       |                                                                               | 4 "       | 17       | 6       | 8       |
|                           | 5 "       | 1        | 0       | 0       |                                                                               | 5 "       | 13       | 0       | 0       |
|                           | 6 "       | 2        | 0       | 0       |                                                                               | 6 "       | 3        | 1       | 1       |
|                           | 2nd line. |          |         |         |                                                                               |           |          |         |         |
|                           | 1 target  | 5        | 0       | 0       |                                                                               |           |          |         |         |
|                           | 2 "       | 16       | 2       | 1       |                                                                               |           |          |         |         |
|                           | 3 "       | 6        | 1       | 2       |                                                                               |           |          |         |         |
|                           | 4 "       | 2        | 0       | 0       |                                                                               |           |          |         |         |
|                           | 5 "       | 0        | 0       | 0       |                                                                               |           |          |         |         |
|                           | 6 "       | 1        | 1       | 0       |                                                                               |           |          |         |         |

## PENETRATION INTO MASONRY.

DESCRIPTION OF TOWER.—(See *Lithograph opposite*).

The Tower was built in the year 1804, and is stated to have cost 3,000*l*. It is of brick, able to accommodate 20 men, with magazine space for 80 barrels or 70 cases of powder. Like all the Martello Towers on this part of the coast, it is designed for one gun. The wall on the side fired at is 7 feet 6 inches thick at the level of the ground, and 5 feet 9 inches at the spring of the vault, which is 19 feet from the ground. It is 31 feet 6 inches high, but receives considerable support, at 12 feet above the ground, from the joists of the floor, which radiate from a central pillar and abutt against it. To a certain extent also the basement floor, at 2½ feet above the ground, may be regarded as a support. In appearance the Tower was perfectly sound, the brickwork having been protected by a coating of plaster. The parapet, 5½ feet high and 5 feet thick, was coped with Bramleyfall stone, in blocks containing 7 or 8 cubic feet; a step 2 feet high, round the interior, served the double purpose of a banquette and of a support for the front racers of a rear pivot-traversing platform turning the entire circle. The racer itself was laid on granite curb-stones of about half a ton weight each. Thus a great solidity characterised the whole structure. The roof was formed of a bomb-proof vault, supported in the centre by a pillar 4 feet in diameter, turned in three courses of bricks, and surmounted by an equal thickness of ordinary brickwork, giving altogether about 5 feet of masonry over the crown of the arch. The diameter of the whole at the top was 40 feet, and nearly 46 feet at the bottom.

*Bexhill, October 19, 1864.*

RANGE, 750 yards.

Right gun.

*1st Round—Common Shell, blind, filled with sand.*

Struck 5 feet left of door, 9 feet 6 inches below the floor line, just above the ground line; penetration, 2 feet 6 inches.

*2nd Round.*

Struck 6 feet 6 inches left of door and 5 feet below the floor line, in exactly the same relative position as the 1st round from the Whitworth gun; the shell passed through the wall, and was found inside unbroken.

*1st Round—Shot, hollow-headed.*

Struck over the granite arch of the platform racer-bed; penetration, 4 feet 7 inches into the upper solid part of tower.

*2nd Round.*

Struck 3 feet 2 inches above the top of the door and immediately over it, cut through a wrought-iron bar 1½ inch square; penetrated 3 feet, and knocked away the top of the door.

*3rd Round.*

Struck full on the solid part of the masonry; penetration, 4 feet 9 inches.

*October 20, 1864.*

COMMON SHELL PILLAR FUZES.

Bursting charge, 4½ lbs.

*1st Round.*

Struck a heap of stones and rubbish at the foot of the tower, and burst before reaching the wall.

*2nd Round.*

Shell penetrated 5 feet and burst; the brickwork on the face removed 4 feet × 4 feet to a mean depth of 2 feet; scaled the wall on the inside 5 feet × 4 feet × 9 inches; one hole 3 feet deep.

## COMMON CASE.

December 21, 1864.

RANGE, 500 yards.

At a line of six 9-foot targets.

|                |                                                  | Through. | Lodged. | Struck. |
|----------------|--------------------------------------------------|----------|---------|---------|
| 1st round -    | 1 target                                         | 6        | 1       | 0       |
|                | 2 "                                              | 5        | 0       | 0       |
| 1½° elevation. | 3 "                                              | 12       | 5       | 0       |
|                | 4 "                                              | 13       | 0       | 0       |
|                | 5 "                                              | 9        | 3       | 1       |
|                | 6 "                                              | 2        | 0       | 0       |
| 2nd round -    | Case came out whole and passed over the targets. |          |         |         |
| 5° elevation.  |                                                  |          |         |         |
| 3rd round -    | 1 target                                         | 2        | 0       | 0       |
|                | 2 "                                              | 1        | 0       | 0       |
| 4° elevation.  | 3 "                                              | 0        | 0       | 0       |
|                | 4 "                                              | 2        | 0       | 1       |
|                | 5 "                                              | 4        | 1       | 2       |
|                | 6 "                                              | 3        | 2       | 2       |
| 4th round -    | 1 target                                         | 3        | 0       | 0       |
|                | 2 "                                              | 3        | 2       | 1       |
| 2° elevation.  | 3 "                                              | 4        | 0       | 0       |
|                | 4 "                                              | 2        | 1       | 0       |
|                | 5 "                                              | 1        | 0       | 0       |
|                | 6 "                                              | 4        | 0       | 0       |
| 5th round      | 1 target                                         | 3        | 0       | 0       |
|                | 2 "                                              | 7        | 1       | 1       |
| 1½° elevation. | 3 "                                              | 12       | 1       | 1       |
|                | 4 "                                              | 6        | 1       | 1       |
|                | 5 "                                              | 5        | 3       | 1       |
|                | 6 "                                              | 7        | 1       | 0       |
| 6th round -    | 1 target                                         | 8        | 1       | 0       |
|                | 2 "                                              | 5        | 0       | 0       |
| 1½° elevation. | 3 "                                              | 1        | 2       | 2       |
|                | 4 "                                              | 2        | 0       | 0       |
|                | 5 "                                              | 6        | 0       | 2       |
|                | 6 "                                              | 3        | 1       | 0       |
| 7th round -    | 1 target                                         | 4        | 1       | 0       |
|                | 2 "                                              | 4        | 0       | 0       |
| 1½° elevation. | 3 "                                              | 3        | 1       | 0       |
|                | 4 "                                              | 3        | 0       | 0       |
|                | 5 "                                              | 2        | 1       | 1       |
|                | 6 "                                              | 4        | 0       | 0       |

RANGE, 300 yards.

|               |          | Through. | Lodged. | Struck. |
|---------------|----------|----------|---------|---------|
| 1st round -   | 1 target | 22       | 0       | 0       |
|               | 2 "      | 16       | 1       | 0       |
| ½° elevation. | 3 "      | 25       | 0       | 1       |
|               | 4 "      | 12       | 0       | 0       |
|               | 5 "      | 23       | 3       | 1       |
|               | 6 "      | 18       | 0       | 0       |
| 2nd round -   | 1 target | 19       | 0       | 0       |
|               | 2 "      | 26       | 0       | 0       |
| 1° elevation. | 3 "      | 26       | 0       | 1       |
|               | 4 "      | 30       | 0       | 1       |
|               | 5 "      | 28       | 0       | 0       |
|               | 6 "      | 20       | 0       | 1       |

The above is the record after three rounds had been fired at each elevation.

RANGE, 100 yards.

|             |          | Through. | Lodged. | Struck. |
|-------------|----------|----------|---------|---------|
| 1st round - | 1 target | 2        | 0       | 0       |
|             | 2 "      | 45       | 0       | 1       |
|             | 3 "      | 129      | 1       | 0       |
|             | 4 "      | 136      | 0       | 0       |
|             | 5 "      | 62       | 0       | 0       |
|             | 6 "      | 15       | 0       | 0       |
| 2nd round   | 1 target | 13       | 0       | 0       |
|             | 2 "      | 44       | 0       | 0       |
|             | 3 "      | 109      | 0       | 1       |
|             | 4 "      | 111      | 1       | 1       |
|             | 5 "      | 55       | 0       | 1       |
|             | 6 "      | 9        | 0       | 1       |

Each record is the result of three rounds of common case.

## TRIAL OF FUZES.

*December 22, 1864.*

Trial of time fuzes. The time was taken with three stop clocks; the fuzes being fixed in segment shell.

Elevation, 3°. Fuze set to .5 of an inch.

| Stop Clock. | 1st Round. | 2nd Round.  | 3rd Round. | 4th Round.  | 5th Round.  |
|-------------|------------|-------------|------------|-------------|-------------|
| No. 1       | sec.<br>0  | sec.<br>1.1 | Blind.     | sec.<br>0.9 | sec.<br>0.9 |
| " 2         | 1.4        | 1.1         |            | 0.9         | 1.0         |
| " 3         | 1.5        | —           |            | 0.9         | 0.9         |

*February 20, 1865.*

Elevation, 4°. Fuze set to 0.5 inch.

| Stop Clock. | 1st Round. | 2nd Round. | 3rd Round. | 4th Round. | 5th Round. |
|-------------|------------|------------|------------|------------|------------|
| No. 1       | sec.       | sec.       | sec.       | sec.       | sec.       |
| " 2         | —          | —          | 1.0        | 1.0        | 0.9        |
| " 3         | 0.9        | 0.9        | —          | 1.0        | 1.0        |

Elevation, 5°. Fuze set to 1.25 inch.

| Stop Clock. | 1st Round.  | 2nd Round.  | 3rd Round.  | 4th Round.  | 5th Round.  |
|-------------|-------------|-------------|-------------|-------------|-------------|
| No. 1       | sec.<br>2.0 | sec.<br>2.3 | sec.<br>2.1 | sec.<br>2.1 | sec.<br>2.0 |
| " 2         | —           | 2.1         | 2.1         | 2.0         | 2.0         |
| " 3         | 2.0         | 2.2         | 2.0         | 2.0         | 1.9         |

Elevation, . Time fuzes set to 2.5 inch.

| Stop Clock. | 1st Round.  | 2nd Round.  | 3rd Round. | 4th Round.  | 5th Round.  |
|-------------|-------------|-------------|------------|-------------|-------------|
| No. 1       | sec.<br>4.3 | sec.<br>4.0 | Blind.     | sec.<br>4.1 | sec.<br>4.4 |
| " 2         | 4.3         | 4.1         |            | 4.0         | 4.3         |
| " 3         | 4.1         | 4.0         |            | —           | 4.2         |

## FUZES.

*December 21, 1864.*

The following experiment was carried on to ascertain whether the common wood fuze could be used with the muzzle-loading guns. 70-pounders; segment shell; charge, 10 lbs.

*Ordinary Lubricator.*

|           |                  |          |
|-----------|------------------|----------|
| 1st round | - M.L. Armstrong | - Burst. |
| "         | - Whitworth      | - Blind. |
| 2nd round | - M.L. Armstrong | - "      |
| "         | - Whitworth      | - "      |
| 3rd round | - M.L. Armstrong | - "      |
| "         | - Whitworth      | - Burst. |
| 4th round | - M.L. Armstrong | - Blind. |
| "         | - Whitworth      | - Burst. |
| 5th round | - M.L. Armstrong | - "      |
| "         | - Whitworth      | - Blind. |
| 6th round | - M.L. Armstrong | - "      |
| "         | - Whitworth      | - "      |
| 7th round | - M.L. Armstrong | - "      |
| "         | - Whitworth      | - "      |

*Without Lubricator.*

|           |                  |                 |
|-----------|------------------|-----------------|
| 1st round | - M.L. Armstrong | - Burst.        |
| "         | - Whitworth      | - "             |
| 2nd round | - M.L. Armstrong | - Burst in gun. |
| "         | - Whitworth      | - Burst.        |
| 3rd round | - M.L. Armstrong | - "             |
| "         | - Whitworth      | - "             |
| 4th round | - M.L. Armstrong | - "             |
| "         | - Whitworth      | - "             |
| 5th round | - M.L. Armstrong | - "             |
| "         | - Whitworth      | - Blind.        |



ROUGH USAGE.

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*June 22, 1865.*

M.L. 70-PR. ARMSTRONG.

To ascertain the effect of shot striking the gun, it was laid on skidding, and fired at with a 40-pr. Armstrong breech-loading gun at a range of 40 yards, with solid cast-iron shot.

*1st Round.*

The gun was laid with its muzzle pointing towards the 40-pr. at an angle of about  $20^{\circ}$  with the line of fire.

Struck 30 inches from the muzzle, made an indent, and dented the shoulder of the trunnion.

The interior of the bore was not damaged; a shot was rammed home.

*2nd Round.*

The gun was laid with its muzzle pointing towards the 40-pr. at an angle of about  $35^{\circ}$  with the line of fire.

Struck close to the last shot and made an indent, and cracked the exterior coil. Interior not damaged. A shot was rammed home.

*3rd Round.*

The gun was laid at angle  $85^{\circ}$ .

Hit on the junction of the two coils in front of the trunnions, cracked the front strengthening coil longitudinally and transversely, and the other transversely.

A shot was rammed home.

*4th Round.*

The gun was laid nearly broadside on its axis, being at  $85^{\circ}$  with the line of fire.

Struck at 46 inches from the muzzle, cracked both the tubes right round, rendering the gun unserviceable.

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Thirty shot were thrown into a wagon and out again in a heap; this was repeated twice. The shot were subsequently fired without difficulty.



## SEA SERVICE TRIALS.

### EASE OF WORKING AS A BROADSIDE GUN.

The gun was mounted on a common truck carriage, having depression chock, bed, and elevating screw, and worked by a crew of 15 men.

The peculiarities appertaining to its fittings and stores, as differing from the land service, are as follows:—

*Sea Service patterns.*—Spill for friction tube with loop and half-cock cleat.

Quill friction tubes.

*Gun gear.*—8-inch breeching (rove through carriage brackets and hitched in the first place to allow a recoil of about six feet).

*Side tackles.*—Blocks 10-inch double for 3-inch falls.

No instrument had been supplied for extracting the charge until the 12th November 1864 (*see below.*)

A 9-inch breeching was rove on the third day.

The extractor, arrived November 12, 1864.

Three tumbler prongs with buttons made to fit over the head of the projectiles, where there are notches corresponding to the buttons; the prongs are made to close and grasp the projectile head by the action of a screw plate at the tumbler ends.

There is an elastic band round the tumbler ends to keep the prongs open.

The extractor is kept in position in the grooves by guides.

October 31, 1864.

#### INDEPENDENT FIRING.

Forty rounds in series of 20, the crew resting in the intervals.

Hollow-headed shot, 70·6 lbs.

Charge, 10 lbs.

Distance for which gun was laid, 2,600 yards (the target having been struck down by a shot from another gun, aim was taken for a pole standing in the range).

Elevation, 5° 30'.

Deflection, 0.

Wind,  ; force, 3.

In the first 20 rounds the intervals between the successive rounds were as follows:—

The Nos. awarded for accuracy are in italics.

| —     | Nos. | —     | Nos. | —     | Nos. | —     | Nos. |
|-------|------|-------|------|-------|------|-------|------|
| m. s. |      | m. s. |      | m. s. |      | m. s. |      |
| 0 0   | 0    | 0 59  | 4    | 0 54  | 4    | 1 5   | 4    |
| 1 0   | 4    | 1 21  | 5    | 1 0   | 4    | 1 1   | 6    |
| 0 55  | 6    | 1 2   | 5    | 0 50  | 5    | 0 45  | 6    |
| 0 51  | 5    | 1 3   | 5    | 1 10  | 6    | 0 55  | 4    |
| 3 50  | 4    | 1 0   | 4    | 1 30  | 6    | 0 50  | 4    |

After the fourth round, two strands having gone in the nip of the clinch, the breeching was shifted in three minutes.

At the 15th round the tube became unhooked, causing a delay of 10 seconds.

Towards the last few rounds the loading Nos. showed signs of fatigue.

Deducting three minutes, the time occupied in shifting breechings, and 10 seconds for the tube accident, the 20 rounds were fired in 18 minutes 41 seconds.

(Average time between each of the rounds, 59 seconds.)

The next 20 rounds were fired with the following intervals.

| —     | Nos. | —     | Nos. | —     | Nos. | —     | Nos. |
|-------|------|-------|------|-------|------|-------|------|
| m. s. |      | m. s. |      | m. s. |      | m. s. |      |
| 0 0   | 6    | 0 55  | 4    | 1 27  | 6    | 0 55  | 5    |
| 0 55  | 5    | 0 48  | 5    | 0 42  | 5    | 0 47  | 5    |
| 0 32  | 6    | 0 54  | 0    | 0 45  | 4    | 0 45  | 5    |
| 0 58  | 6    | 0 45  | 5    | 0 56  | 5    | 0 39  | 5    |
| 0 45  | 6    | 1 9   | 4    | 0 58  | 4    | 0 53  | 4    |

The elevation had to be corrected at the 11th round.

After the 14th round 3 and 5 exchanged places ;

the work of loading beginning to tell upon 3 and 4.

The 20 rounds were fired in 16 minutes 28 seconds.

(Average time between each of the rounds, 52 seconds.)

November 1, 1864.

Twelve rounds were fired for a comparison with the Whitworth 12 rounds of this date.

| —     | Nos. | —     | Nos. | —     | Nos. |
|-------|------|-------|------|-------|------|
| m. s. |      | m. s. |      | m. s. |      |
| 0 0   | 0    | 0 47  | 5    | 0 55  | 5    |
| 0 48  | 6    | 1 6   | 4    | 0 45  | 5    |
| 0 55  | 5    | 0 57  | 5    | 0 46  | 5    |
| 1 3   | 5    | 0 49  | 0    | 1 5   | 6    |

At the last round the powderman forgot to bring up the lubricator, delaying the gun 10 seconds.

Deducting this time, the 12 rounds were fired in 9 minutes 46 seconds.

(Average time between each of the rounds 53·3 seconds.)

The crew showed signs of fatigue towards the latter part of this practice, having fired previously in the course of about an hour,—

20 rounds from 8-inch gun,  
12 rounds from Whitworth gun.

EASE OF WORKING—*continued.*

October 31, 1864.

## QUICK FIRING.

Eighty rounds in series of 20 ; the crew resting in the intervals.

Shot, 70·6 lbs. Charge, 10 lbs.

5° 30' elevation was given on account of the danger attending ricochet in Portsmouth Harbour, and the direction also had to be brought on by the hand-spikes for the same reason.

In the first 20 rounds the intervals between the successive rounds were as follows :—

| m. | s. | m. | s. | m. | s. | m. | s. |
|----|----|----|----|----|----|----|----|
| 0  | 0  | *1 | 10 | 0  | 40 | *1 | 55 |
| 0  | 55 | 0  | 50 | 0  | 44 | 0  | 45 |
| *1 | 25 | 0  | 45 | 0  | 54 | 0  | 41 |
| 0  | 46 | 0  | 50 | 0  | 52 | 0  | 44 |
| 0  | 44 | 0  | 35 | 0  | 40 | 0  | 45 |

A delay of 15 seconds in loading for the third round, No. 3 having entered the studs into the shallow grooves ; this time is not deducted.

In loading for the sixth round the rammer head was broken.

Waiting for another rammer delayed the gun 10 seconds.

After the 14th round, 3 and 5 exchanged places, and after the 15th round, 4 and 6 exchanged places.

At the 15th round, the hook of the right side tackle was carried away, and in loading the cartridge burst at the choke ; shifting the side tackle, clearing away the broken cartridge, sweeping and wet swabbing the deck, delayed the gun 1 minute.

Deducting 1 minute 10 seconds for these mishaps, the 20 rounds were completed in 14 minutes 40 seconds.

(Average time between each of the rounds, 46·3 seconds.)

The next 20 rounds were performed with the following intervals of time :—

| m. | s. | m. | s. | m. | s. | m. | s. |
|----|----|----|----|----|----|----|----|
| 0  | 0  | 0  | 44 | 0  | 41 | *0 | 47 |
| 0  | 45 | 0  | 36 | 0  | 40 | 0  | 35 |
| 0  | 45 | 0  | 45 | 0  | 40 | 0  | 45 |
| 0  | 39 | 0  | 40 | 0  | 35 | 0  | 44 |
| 0  | 51 | 0  | 39 | 0  | 43 | 0  | 41 |

At the 15th round, the hook of the right side tackle carried away, the delay arising therefrom was 13 seconds.

Deducting this, the 20 rounds were fired in 13 minutes 2 seconds.

(Average time between each of the rounds, 41·3 seconds.)

November 2, 1864.

Twenty rounds were fired under the same circumstances as yesterday, except that a new 9-inch breeching had been rove, allowing 7 feet recoil.

Wind  ; force, 3.

| m. | s. | m. | s. | m. | s. | m. | s. |
|----|----|----|----|----|----|----|----|
| 0  | 0  | 0  | 30 | *0 | 42 | 0  | 29 |
| 0  | 35 | 0  | 28 | 0  | 41 | 0  | 31 |
| 0  | 29 | 0  | 36 | 0  | 32 | 0  | 31 |
| 0  | 40 | 0  | 30 | 0  | 26 | 0  | 30 |
| 0  | 30 | 0  | 30 | *0 | 35 | 0  | 29 |

Hook of left side tackle carried away at 10th round, delaying gun 10 seconds.

Hook of right side tackle carried away at 14th round, delaying gun 5 seconds.

Deducting 15 seconds, the time occupied in firing the 20 rounds was 9 minutes 59 seconds.

(Average time between each of the rounds, 31½ seconds.)

The loading Nos. were not changed as before. In loading for the 7th round, the shot hung at the muzzle a short time, evidently in a wrong groove.

November 3, 1864.

## QUICK FIRING, WITHOUT LUBRICATORS.

Twenty rounds were fired under the same circumstances as yesterday.

The breeching was hitched to allow 6 feet recoil.

Wind  ; force, 2 to 3.

| m. | s. | m. | s. | m. | s. | m. | s. |
|----|----|----|----|----|----|----|----|
| 0  | 0  | 0  | 28 | 0  | 33 | 0  | 28 |
| 0  | 31 | 0  | 36 | 0  | 29 | 0  | 32 |
| 0  | 32 | 0  | 30 | 0  | 33 | 0  | 29 |
| 0  | 37 | 0  | 51 | 0  | 29 | 0  | 30 |
| 0  | 28 | *0 | 30 | 0  | 29 | 0  | 30 |

At the 8th round, hook of right side tackle was carried away, delaying the gun 10 seconds.

Deducting this time, the 20 rounds were fired in 9 minutes 55 seconds.

(The average time between each of the rounds, 31·3 seconds.)

No difficulty was experienced in loading.

The gun was prevented in some measure from springing out again after the recoil, as the muzzle dropped by the reaction from "taut breeching," and took against the sweep piece until again freed by hauling on the train tackle.

At the conclusion of the firing the breeching had stretched out to about 7 feet 6 inches.

EASE OF WORKING (PIVOTING SLIDE CARRIAGE).

November 7, 1864.

FIRING AT SPITHEAD, EN RICOCHET.  
EMPTY SHELL.

Ten rounds were fired en ricochet, the gun being laid for the horizon with 1° elevation.  
Empty shell (common), 64½ lbs.  
Length of shell, 14·64 inches.  
Charge, 10 lbs.

The deviation after 1st graze is recorded below, and the "time of flight" between the 1st and 2nd grazes shows approximately the height to which the projectiles rose after striking the water, thus exhibiting the uncertainty of hitting the enemy "en ricochet."

| Rounds. | Deviation after 1st Graze. | Time of Flight between 1st and 2nd Grazes. | Rounds. | Deviation after 1st Graze. | Time of Flight between 1st and 2nd Grazes. |
|---------|----------------------------|--------------------------------------------|---------|----------------------------|--------------------------------------------|
|         | °                          | "                                          |         | °                          | "                                          |
| 1       | 3                          | 3½                                         | 6       | 1½                         | 8                                          |
| 2       | 2                          | 11¼                                        | 7       | 1½                         | 4                                          |
| 3       | 3                          | 6½                                         | 8       | 1½                         | 6                                          |
| 4       | 2½                         | 6                                          | 9       | 1½                         | 6                                          |
| 5       | 3                          | 4¾                                         | 10      | 5                          | Not taken, but a long time.                |

SHELL WITH PERCUSSION FUZES (experimental pillar).

Ten rounds were then fired with common shell (filled) and percussion fuzes, the circumstances being the same as above.  
The failure of a fuze is also recorded here.

| Rounds. | Deviation after 1st Graze. | Time of Flight between 1st and 2nd Grazes. | Rounds. | Deviation after 1st Graze.   | Time of Flight between 1st and 2nd Grazes. |
|---------|----------------------------|--------------------------------------------|---------|------------------------------|--------------------------------------------|
|         | °                          | "                                          |         | °                            | "                                          |
| 1       | 3                          | 4½                                         | 6       | 4                            | 7¾                                         |
| 2       | 4                          | 9                                          | 7       | 1                            | 1½                                         |
| 3       | Burst at muzzle.           |                                            | 8       | 1½                           | 5                                          |
| 4       |                            | 1                                          | 9       | 2                            | 7                                          |
| 5       | 1½                         | 4                                          | 10      | Not seen, but did not burst. |                                            |

SHELL WITH PERCUSSION FUZES:  
1 to 5 (service pillar), 6 to 10 (Pettman's).

Ten rounds were fired with common shell filled, the first five with the service pillar fuzes, the remainder with the service, Pettman's, fuzes for spherical shell; the conditions of elevation, &c. the same as before mentioned. The failure of the fuzes is also recorded here.

| Rounds. | Deviation after 1st Graze. | Time of Flight between 1st and 2nd Grazes. | Rounds. | Deviation after 1st Graze. | Time of Flight between 1st and 2nd Grazes. |
|---------|----------------------------|--------------------------------------------|---------|----------------------------|--------------------------------------------|
|         | °                          | "                                          |         | °                          | "                                          |
| 1       | 5                          | 15                                         | 6       | 5                          | 5½                                         |
| 2       | 4½                         | 11½                                        | 7       | Burst, 1st graze.          |                                            |
| 3       | 2½                         | 5                                          | 8       | 15                         | 14                                         |
| 4       | Burst at muzzle.           |                                            | 9       | 7                          | 7¾                                         |
| 5       | 6½                         | 11                                         | 10      | ½                          | 1                                          |

SHOT EN RICOCHET.

Five rounds with shot fired under the same conditions.

| Rounds. | Deviation after 1st Graze. | Time of Flight between 1st and 2nd Grazes. |
|---------|----------------------------|--------------------------------------------|
|         | °                          | "                                          |
| 1       | 5                          | 13½                                        |
| 2       | 5                          | 2½                                         |
| 3       | 9                          | 5¾                                         |
| 4       | 8                          | 4½                                         |
| 5       | 9                          | 4½                                         |

The number and distance of the rebounds varied very much during the practice; sometimes there was no second rebound, and at others several grazes were seen to strike at short distances apart.

REMARKS.

The practice was throughout the firing very good.  
Recoil, moderate.—Before commencing the firing the breeching was hitched to allow the gun to come in about 6 feet. After the fourth round, two strands having gone in the nip of the clinch, the breeching was shifted, and the gun then gradually closed up the hitch until, at the conclusion of the first day's firing, the breeching had straightened out to allow a recoil of 8 feet 4 inches.

The breeching should have been 9-inch rope for a gun of this weight.  
A 9-inch breeching was rove on the third day of the practice.

The loading.—The lubricators were too high. No. 4 had to thrust them in with the rammer to make room for entering the shot.  
3 and 4 rammed home with their feet bearing against the sweep piece, but the shot went home hand over hand and without any check.

Running out was performed with ease, especially on November 1st, when the ship had ¾ list towards the object, but it was not equal to the wedge gun in this respect, which had the five loading numbers less to man the side tackles and not so far to travel.

The latter is also about 14 cwt. lighter than the shunt gun.

Pointing, with one handspike and without the aid of side tackle, was no difficulty, but the work in this respect was greater than at the wedge in about the proportion of their respective weights.



SEA SERVICE TRIALS—*continued*.

PRACTICE with COMMON SHELL and PERCUSSION FUZES, from the 70-pounder M.L. ARMSTRONG GUN mounted (on Naval Slide Carriages) on board the Gunboat "STORK," in PORTSMOUTH HARBOUR. Target, "ALFRED," wooden Frigate, distant 700 yards.

|                      |             | Ft. | in. |
|----------------------|-------------|-----|-----|
| Thickness of side at | Upper works | - 1 | 5   |
|                      | Main deck   | - 2 | 0   |
|                      | Bends       | - 2 | 5   |

Oak timbers and planking. The main-deck ports were filled in with fir to the thickness of ship's side.

Hit direct.—November 4, 1864.

## Pillar Percussion Fuze (present Service Gauge).

|                       |                 |   | Elevation 1° 28'. |
|-----------------------|-----------------|---|-------------------|
| Shell                 | -               | - | 64½ lbs.          |
| Burster               | -               | - | 4½ "              |
|                       |                 |   | 69 "              |
| Length, 14·64 inches. |                 |   |                   |
| Thickness             | { 1·25 (sides). |   |                   |
|                       | { 1·94 (base).  |   |                   |

12 rounds were fired with the following results :—

- |    |                                           |
|----|-------------------------------------------|
| 1  | No burst, passed over.                    |
| 2  | Premature (at muzzle).                    |
| 3  | Do.                                       |
| 4  | No burst (struck water 450 yards beyond). |
| 5  | Premature (at muzzle).                    |
| 6  | Do.                                       |
| 7  | Do.                                       |
| 8  | Burst.                                    |
| 9  | Premature (100 yards from muzzle).        |
| 10 | Burst.                                    |
| 11 | Burst.                                    |
| 12 | Burst.                                    |

\* The effect of the first explosion not noticed, so many of the other shells having burst in the neighbourhood before.

November 14 and 15, 1864.

- |    |                                                                       |
|----|-----------------------------------------------------------------------|
| 13 | Burst 4 feet in, blowing up four main-deck planks, and sprung a beam. |
| 14 | Burst.                                                                |
| 15 | Burst.                                                                |
| 16 | Burst.                                                                |
| 17 | Burst.                                                                |
| 18 | Burst.                                                                |
| 19 | Burst (in the opposite side).                                         |
| 20 | Burst.                                                                |
| 21 | Burst.                                                                |
| 22 | Premature (at muzzle).                                                |
| 23 | Burst.                                                                |
| 24 | Burst (in the opposite side).                                         |
| 25 | Burst.                                                                |
| 26 | Burst (intended for ricochet).                                        |
| 27 | Burst do.                                                             |
| 28 | — — —                                                                 |
| 29 | — — —                                                                 |
| 30 | — — —                                                                 |

On examination in-board, several of the above explosions were observed to have taken place within 5 feet of the near side of ship.

ABSTRACT OF SEA SERVICE TRIALS—*continued.*En Ricochet.—*November 14 and 15, 1864.*

| Rounds. | Struck<br>Water<br>short of<br>the<br>Ship. | Armstrong M.L. (Shunt).                                                                          |
|---------|---------------------------------------------|--------------------------------------------------------------------------------------------------|
|         | Yards.                                      |                                                                                                  |
| 1       | 50                                          | Burst, fracturing shelf piece, and blowing up several lower-deck planks.                         |
| 2       | 5                                           | Burst (probably struck broadways on), opening ship's side to the extent of 4 feet (irregularly). |
| 3       | 20                                          | Burst (in-board).                                                                                |
| 4       | 5                                           | Burst (close to No. 2, enlarging hole to 8 feet $\times$ 4 feet.                                 |
| 5       | —                                           | Premature (about 20 yards from muzzle).                                                          |
| 6       | 70                                          | Burst.                                                                                           |
| 7       | 60                                          | Burst.                                                                                           |
| 8       | 30                                          | Burst.                                                                                           |
| 9       | 40                                          | Burst.                                                                                           |
| 10      | 55                                          | Burst.                                                                                           |
| 11      | —                                           | Premature (about 50 yards from muzzle).                                                          |
| 12      | 40                                          | Burst.                                                                                           |
| 13      | 10                                          | Burst.                                                                                           |
| 14      | 20                                          | Burst.                                                                                           |
| 15      | 20                                          | Burst.                                                                                           |
| 16      | 25                                          | Burst.                                                                                           |

## ABSTRACT from the REPORT of the SEA SERVICE TRIALS.

The Time was taken from the firing of the first Round to the firing of the last Round in each Series, striking the Average at the Conclusion by dividing by the Number of Rounds less One. Deductions only were made where delays occurred from mishaps totally unconnected with the System or Construction of the Guns. The Numbers for Accuracy are awarded according to the Method usually adopted in "EXCELLENT," from 0 to 3 for ELEVATION, from 0 to 3 for DIRECTION.

|                                                           |                                            | ARMSTRONG, M.L. (Shunt).                                                                                                                                                                    |                |                          |                                                                                                        |                                                                             |
|-----------------------------------------------------------|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|--------------------------|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| 70-pounder gun, mounted on the lower deck of "Excellent." |                                            | Rounds.                                                                                                                                                                                     | Time.          | Average Time each Round. | Numbers awarded for Accuracy.                                                                          | Remarks.                                                                    |
| Independent firing, 2,600 yards.<br>October 31, 1864.     |                                            | 20                                                                                                                                                                                          | m. s.<br>18 41 | sec.<br>59.0             | 91                                                                                                     | After 4th round shifted breeching. Elevation corrected at the 11th round.   |
|                                                           |                                            | 20                                                                                                                                                                                          | 16 28          | 52.0                     | 95                                                                                                     |                                                                             |
|                                                           | November 1, 1864.                          | 12                                                                                                                                                                                          | 9 46           | 53.3                     | 51                                                                                                     | The crew that worked this gun had more continuous work than the other crew. |
|                                                           | Total Nos.                                 | -                                                                                                                                                                                           | -              | -                        | 237                                                                                                    |                                                                             |
| Directional quick firing.<br>Elevation, 5° to 6°.         |                                            | 20                                                                                                                                                                                          | 14 40          | 46.3                     | Once or twice there was a delay of a few seconds, from the shot being entered upon the shallow groove. |                                                                             |
|                                                           | October 31, 1864.                          | 20                                                                                                                                                                                          | 13 2           | 41.3                     |                                                                                                        |                                                                             |
|                                                           | November 2, 1864.<br>New 9-inch breeching. | 20                                                                                                                                                                                          | 9 59           | 31.5                     |                                                                                                        |                                                                             |
|                                                           | November 3, 1864.<br>Without lubricators   | 20                                                                                                                                                                                          | 9 55           | 31.3                     |                                                                                                        |                                                                             |
|                                                           | Totals                                     | -                                                                                                                                                                                           | 132            | 92 31                    | 45                                                                                                     |                                                                             |
| 8-inch gun on the lower deck of "Excellent."              |                                            | The men advanced in smartness as the firing proceeded ; this gave a great advantage to the Whitworth over the Shunt gun, as the former did not take up the rapid firing till the third day. |                |                          |                                                                                                        |                                                                             |
| Independent firing, 1,800 yards.                          |                                            |                                                                                                                                                                                             |                |                          |                                                                                                        |                                                                             |
| November 1, 1864.                                         |                                            |                                                                                                                                                                                             |                |                          |                                                                                                        |                                                                             |
| Directional quick firing.<br>Elevation, 5°.               |                                            |                                                                                                                                                                                             |                |                          |                                                                                                        |                                                                             |
| November 1, 1864.                                         |                                            |                                                                                                                                                                                             |                |                          |                                                                                                        |                                                                             |

|                                                                                                                          | Rounds. | No. Burst.                 | Average dist. of Explosion from Ship's side. | Pre-mature.        | Blind.                | Remarks.                                                                 |
|--------------------------------------------------------------------------------------------------------------------------|---------|----------------------------|----------------------------------------------|--------------------|-----------------------|--------------------------------------------------------------------------|
| Shell and percussion fuzes against "Alfred," 700 yards.<br>November 4, 1864.<br>Hit direct.<br>November 14 and 15, 1864. | 12      | 4                          | 5 feet.                                      | 6                  | -                     | 2 missed ship, did not burst beyond.                                     |
|                                                                                                                          | 15      | 14                         | Do.                                          | 1                  | 0                     |                                                                          |
| Hit en ricochet                                                                                                          | 16      | 14                         | Generally close to shelf piece.              | 2                  |                       | An aperture opened in ship's side, 8 ft. x 4 ft., the work of two shell. |
| Ricochet Practice.                                                                                                       | Rounds. | Average.                   |                                              | Failures of Fuzes. |                       | Remarks.                                                                 |
| 1° Elevation.                                                                                                            |         | Deviation after 1st Graze. | Time of Flight between 1st and 2nd Graze.    |                    |                       |                                                                          |
| November 7, 1864.                                                                                                        |         |                            |                                              |                    |                       |                                                                          |
| Empty shell                                                                                                              | 10      | 2½°                        | 6"                                           | 1 burst at muzzle. |                       | Expl. pillar fuzes.                                                      |
| Shell and percussion fuzes                                                                                               | 10      | 2½°                        | 5"                                           |                    |                       |                                                                          |
| Shot                                                                                                                     | 5       | 7°                         | 6                                            |                    |                       |                                                                          |
| T tal                                                                                                                    | 25      | 4° Mean                    | 6"                                           | 1                  |                       |                                                                          |
| Additional Practice.                                                                                                     | 5       | 4½°                        | 10½"                                         | 1 burst at muzzle. | 1 burst at 1st graze. | Service pillar fuzes.                                                    |
| Shell and percussion fuzes.                                                                                              | 5       | 7°                         | 7"                                           |                    |                       | Service Pettman's fuzes for shell.                                       |



## PRACTICE AGAINST IRON PLATES.

*June 23, 1864.*

The practice was carried on against a target  $10 \times 20$  feet, representing a section of the "Warrior," supported at the back in the usual manner.

RANGE, 800 yards.

Charge, 14 lbs. ; for round shot, 18 lbs.

|                                        |     |          |
|----------------------------------------|-----|----------|
|                                        |     | lbs. oz. |
| Weight of steel round shot             | - - | 39 14    |
| Diameter, 6.35 inches.                 |     |          |
| Weight of steel elongated shot         | - - | 69 12    |
| Length, 9.9 inches.                    |     |          |
| Diameter, 6.3 inches.                  |     |          |
| Weight of steel elongated shell, empty | 68  | 7        |
| Bursting charge                        | - - | 2 0      |
| Length, 12.21 inches.                  |     |          |
| Diameter, 6.34 inches.                 |     |          |

Number of the gun, 60.

*1st Round—Elongated Shot.*

Struck 1 foot from the upper edge of the plate, and 7 feet 2 inches from left edge, on a securing bolt, broke the plate, and drove the fragments in 5 inches in depth ; shot bounded back without breaking up ; the shot shortened to 8 inches ; diameter increased to 6.8 inches ; damage in-board, nil.

*2nd Round—Elongated Shot.*

Hit on the left edge of the target, 9 inches from the top, passed through the plate and part of the backing ; the shot passed out sideways out to sea ; damage in-board, nil.

*3rd Round—Elongated Shell.*

Struck the lower plate 7 feet 6 inches from the left edge, 2 feet 1 inch from the bottom, and  $1\frac{1}{2}$  inches from a securing bolt ; depth of indent, 2.5 inches ; the charge of the shell burst ; the shell did not break up, and was found 400 yards in front of the target ; damage in-board, one armour bolt started .5 inches.

*June 24, 1864.*

No. 59 gun.

RANGE, 50 yards.

*1st Round—Round Shot.*

Struck  $5\frac{1}{2}$  feet from the bottom, 7 feet 8 inches from the right edge, and directly in the wake of horizontal stringer ; the shot broke up and remained embedded in the target 8 inches ; damage in-board, one armour bolt and one rivet broken.

*2nd Round—Elongated Shell.*

Struck 7 feet 7 inches from the right edge and 3 feet 4 inches from the bottom on the joining of two plates ; passed through the plate, driving in the fragments  $9\frac{1}{4}$  inches ; shell bounded back 20 yards without breaking up ; the bursting charge set fire to the backing ; one bucket of water sufficed to extinguish it ; the lower plate driven out half an inch ; nine

bolts in lower plate started forward  $1\frac{1}{2}$  inches each ; damage in-board, nine armour bolts and one backing bolt broken, and one armour bolt started.

No. 60 gun.

RANGE, 600 yards.

*1st Round—Elongated Shot.*

Struck 4 feet 6 inches from the left edge of the target, 5 feet from bottom, and 9 inches from a former fracture ; shot buried itself in the target, 1 inch of the base projecting ; damage in-board, nil.

*2nd Round—Shell.*

Struck 3 feet 3 inches from the right edge and 2 feet 8 inches from the bottom of the target ; bursting charge ignited ; depth of indent,  $1\frac{1}{2}$  inches ; damage in-board, several bolts slightly started.

*June 27, 1864.*

No. 60 gun.

RANGE, 200 yards.

*1st Round—Elongated Shot.*

Struck 5 feet  $4\frac{1}{2}$  inches from the right edge and 2 feet  $3\frac{1}{2}$  inches from the bottom of the target, and 3 inches from a bolt hole ; penetrated the plate and buried itself in the backing ; the base of the shot was 8 inches inside the face of the plate ; damage in-board, the skin was slightly bulged in the wake of the blow.

*2nd Round—Elongated Shell.*

Struck 6 feet 4 inches from the right edge and 3 feet  $2\frac{1}{2}$  inches from the top of the target on the joint of two plates ; 12 securing bolts were drawn from 1 to  $1\frac{1}{2}$  inches and one bolt broken off and thrown to the front ; the upper plate started  $1\frac{3}{4}$  inches from the backing at the right end ; the timber in the wake of the blow drawn upwards 1 inch ; damage in-board, seven securing bolts broken, one backing bolt broken, and one started ; the shell penetrated 6.4 inches from the face and was thrown back 30 yards ; the charge exploded, but did not break the shell.

*July 1, 1864.*

RANGE, 50 yards.

*Elongated Shot.*

Struck 6 feet 8 inches from the left edge and 5 feet 6 inches from the bottom of the target ; shot passed through the plate, the base being about 3.7 inches inside the face of the plate ; the shot struck immediately over the horizontal stringer ; damage in-board skin bulged and slightly cracked, two backing bolts broken ; one rib cracked.

## PRACTICE AGAINST ARMOUR PLATES PLACED AT AN ANGLE OF 52° FROM THE PERPENDICULAR.

*April 26, 1865.*

RANGE, 200 yards.

Charge, 14 lbs. ; steel shot, round end.

The plates made by Petit, Gaudin, & Co., were 15 feet by 3 feet 4 inches by  $4\frac{1}{2}$  inches, and were supported on strong wooden frames at 52°.

*1st Round.*

Struck 3 feet 7 inches from the bottom, and in centre of plate, made an indent 15 inches long and 7 inches broad, and a hole about 2 inches square through the plate. Two large pieces were torn off the back of the plate, and driven to the rear, another piece of the plate bent back.

Shot broke up.

*2nd Round.*

Struck 6 inches from the edge of the plate, made an indent 14 inches long,  $4\frac{1}{2}$  inches deep, and  $6\frac{3}{4}$  inches broad ; plate cracked through, and opened out at back ; a large piece of the back torn off.

Shot broke up.

*3rd Round.*

To test the uniformity of the plates, this round was fired at the plate previously struck by the Whitworth shot.

Struck  $9\frac{1}{2}$  inches from the edge of the plate, and 11 feet 2 inches from the bottom ; made an indent 14 inches long, 7 inches broad, and  $5\frac{1}{2}$  inches deep.

The back of the plate bulged and cracked through in several places across the indent ; a large piece of the back torn off.

Shot broke up.

## RAPID FIRING.

*July 6, 1864.*

The gun was mounted on a rear chock carriage on an ordinary ground platform and worked by men of the Royal Artillery.

The detachments were changed every 20 rounds.

*Shot.*

The 1st 20 rounds were fired in 27 minutes.

At the 17th round the shot stuck, and required 37 blows to drive it home; six men were at the rammer. The sponge was wetted at the 18th round.

|                                 |     |       |
|---------------------------------|-----|-------|
| The 2nd 20 rounds were fired in | 23½ | "     |
| 3rd                             | "   | " 24  |
| 4th                             | "   | " 18½ |
| 5th                             | "   | " 19  |
| 6th                             | "   | " 20½ |

Water was used throughout the experiment after the 17th round; three buckets full were used for the 120 rounds.

A sponge with a spring scraper was used throughout.

The use of the above was attended with great labour to the men.

The shot were high gauge and were difficult to ram home.

25 rounds with 14-lb. charges were fired as rapidly as possible.

## SIR W. ARMSTRONG'S PROGRAMME.

December 6, 1864.

Hollow-headed shot.  
 Charge, 14 lbs.  
 Diameter, 6 inches.  
 Length, 13·75 inches.  
 Elevation, 5° by quadrant.

| Round. | Range. | Right Deflection. | Remarks.                                          |
|--------|--------|-------------------|---------------------------------------------------|
| 1      | 2,836  | 13·0              | Weather :—Thick haze on water, 10 a.m.            |
| 2      | 2,785  | 18·4              | Very do. do. 3 p.m.                               |
| 3      | 2,838  | 16·0              | Wind :—Direction, S.W. by W. ; force, 2 ; 10 a.m. |
| 4      | 2,845  | 15·4              | " W.S.W. " 2 ; 3 p.m.                             |
| 5      | 2,806  | 18·4              | Thermometer :—47 dry, 46 wet, 10 a.m.             |
| 6      | 2,799  | 16·2              | 48 " 47 " 3 p.m.                                  |
| 7      | 2,828  | 18·4              | Reading. Temperature.                             |
| 8      | 2,740  | 13·6              | Barometer :—30·00 49 10 a.m.                      |
| 9      | 2,740  | 16·6              | 30·00 50 3 p.m.                                   |
| 10     | 2,815  | 15·0              |                                                   |

March 3, 1865.

Common shell, weighted, 69·75 lbs.  
 Charge, 14 lbs.  
 Diameter of cartridge, 6 inches.  
 Elevation, 7° by quadrant.

| Round. | Range. | Right Deflection. | Remarks.                                          |
|--------|--------|-------------------|---------------------------------------------------|
| 1      | 3,652  | 24·0              | Weather :—Hazy.                                   |
| 2      | 3,586  | 23·8              | Wind :—Direction, N.W. by W. ; force, 4 ; 10 a.m. |
| 3      | 3,609  | 23·0              | " N.N.W. " 3 ; 3 p.m.                             |
| 4      | 3,500  | 21·6              | Thermometer :—39 dry, 37 wet, 10 a.m.             |
| 5      | 3,662  | 23·2              | 46 " 43 " 3 p.m.                                  |
| 6      | 3,500  | 21·6              | Reading. Temperature.                             |
| 7      | 3,616  | 22·0              | Barometer :—29·75 44 10 a.m.                      |
| 8      | 3,593  | 24·4              | 29·80 46 3 p.m.                                   |
| 9      | 3,537  | 29·0              |                                                   |
| 10     | 3,609  | 28·0              |                                                   |

March 21, 1865.

Elevation, 10° by quadrant.

| Round. | Range. | Right Deflection. | Remarks. |
|--------|--------|-------------------|----------|
| 1      | 4,403  | 55                |          |
| 2      | 4,443  | 54                |          |
| 3      | 4,429  | 53                |          |
| 4      | 4,403  | 51                |          |
| 5      | 4,427  | 47                |          |
| 6      | 4,418  | 56                |          |
| 7      | 4,408  | 50                |          |
| 8      | 4,445  | 51                |          |
| 9      | 4,468  | 53                |          |

## COMMITTEE'S PROGRAMME.

## LONG COMMON SHELL.

|                 |   |   |               |
|-----------------|---|---|---------------|
| Weight, empty   | - | - | 66.25 lbs.    |
| Diameter        | - | - | 6.34 inches.  |
| Length          | - | - | 20 inches.    |
| Bursting charge | - | - | 9 lbs. 3 ozs. |
| Charge          | - | - | 12 lbs.       |
| Length -        | - | - | 12 inches.    |

Studs made of zinc.

| Round. | Elevation. | Range. | Left.  | Line. | Right. | Remarks.                                                  |
|--------|------------|--------|--------|-------|--------|-----------------------------------------------------------|
|        |            | Yards. | Yards. |       | Yards. | <i>April 3, 1865.</i>                                     |
| 1      | 0          | 2,083  | 0.4    | —     | —      |                                                           |
| 2      | "          | 2,128  | —      | —     | 1.2    |                                                           |
| 3      | "          | 2,150  | —      | —     | 0.4    |                                                           |
| 4      | "          | 2,104  | 0.8    | —     | —      |                                                           |
| 5      | "          | 2,050  | 3.2    | —     | —      |                                                           |
| 6      | "          | 2,103  | —      | —     | 0.6    |                                                           |
| 7      | "          | 2,063  | 2.4    | —     | —      |                                                           |
| 8      | "          | 2,122  | —      | Yes.  | —      |                                                           |
| 9      | "          | 2,109  | 1.2    | —     | —      |                                                           |
| 10     | "          | 2,144  | —      | —     | 0.8    |                                                           |
|        |            |        |        |       |        | <i>April 19, 1865.</i>                                    |
| 1      | 10         | 3,974  | —      | —     | 20.8   |                                                           |
| 2      | "          | 4,129  | —      | —     | 27.0   | Weighted up to 75 lbs. 4 ozs. 13 drs.                     |
| 3      | "          | 4,191  | —      | —     | 16.0   | Charge 12 lbs.                                            |
| 4      | "          | 1,644  | —      | —     | 23.0   | Shell rode out of the grooves.                            |
| 5      | "          | 2,100  | —      | —     | —      | This round not measured.                                  |
| 6      | "          | 4,032  | —      | —     | 20.0   |                                                           |
| 7      | "          | 4,094  | —      | —     | 21.0   |                                                           |
| 8      | "          | 4,088  | —      | —     | 18.6   |                                                           |
| 9      | "          | 1,560  | 6.0    | —     | —      | } These shells rode out of the grooves.<br>Studs sheared. |
| 10     | "          | 2,504  | —      | —     | 19.6   |                                                           |
| 11     | "          | 4,062  | —      | —     | 21.0   |                                                           |
| 12     | "          | 4,096  | —      | —     | 24.0   |                                                           |
| 13     | "          | 3,924  | —      | —     | 19.0   |                                                           |
| 14     | "          | 4,129  | —      | —     | 25.0   |                                                           |
| 15     | "          | 4,062  | —      | —     | 21.0   |                                                           |



# FIRST SERIES.—70-POUNDER WEDGE BREECH-LOADING ARMSTRONG.

## EXPERIMENTS FOR DETERMINING RANGE AND ACCURACY.

### SHOT (HOLLOW-HEADED).

SHOEBURYNNESS.

*Ordnance.*  
 Weight, 61·6 cwt.  
 Length, 9 ft. 2 in.  
 Diameter of bore, 6·405 in.  
 Length of bore, 9 ft. 2 in.  
 Grooves { No. 70.  
           { Width, 0·175 in.  
           { Depth, 0·85 in.  
 Spiral, 1 in 37 calibres.

*Projectile and Ammunition.*

Weight, 71½ lbs.  
 Diameter, 6·43 in.  
 Length, 12·26 in.  
 Length of cartridge, 12 in.  
 Diameter of cartridge, 5 in.  
 Brand of powder, A 4.  
 Charge, 9 lbs  
 Wad, service lubricator.

| No. of Round. | Elevation.   | Range. | Recoil. | 1st Graze. |        | Remarks.                                                                                                                                                                               |          |              |       |    |       |    |
|---------------|--------------|--------|---------|------------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        |         | In Line.   | Right. |                                                                                                                                                                                        |          |              |       |    |       |    |
|               | °            | Yards. | Ft. In. |            | Yards. |                                                                                                                                                                                        |          |              |       |    |       |    |
| 13            | 0            | 417    | —       | —          | 0·4    | June 28, 1864.                                                                                                                                                                         |          |              |       |    |       |    |
| 14            | "            | 408    | —       | —          | 0·8    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 15            | "            | 415    | —       | —          | 0·6    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 16            | "            | 423    | —       | —          | 0·6    | The gun was on the line.                                                                                                                                                               |          |              |       |    |       |    |
| 17            | "            | 403    | —       | —          | 0·6    | Weather :—Thick haze on water, 10 a.m.<br>Very thick haze and slight rain, 3 p.m.                                                                                                      |          |              |       |    |       |    |
| 18            | "            | 408    | —       | —          | 0·8    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 19            | "            | 432    | —       | —          | 0·6    | Wind :—Direction, N.W. by W.; force, 4; 10 a.m.<br>" S.W. by W.; " 3; 3 p.m.                                                                                                           |          |              |       |    |       |    |
| 20            | "            | 409    | —       | —          | 0·6    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 21            | "            | 433    | —       | —          | 0·6    | Thermometer :—61 dry, 58 wet, 10 a.m.<br>64 " 61 " 3 p.m.                                                                                                                              |          |              |       |    |       |    |
| 22            | "            | 411    | —       | —          | 0·6    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 23            | "            | 439    | —       | —          | 1·0    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·18</td><td>60</td></tr><tr><td>30·00</td><td>62</td></tr></table> 10 a.m.<br>3 p.m.                      | Reading. | Temperature. | 30·18 | 60 | 30·00 | 62 |
| Reading.      | Temperature. |        |         |            |        |                                                                                                                                                                                        |          |              |       |    |       |    |
| 30·18         | 60           |        |         |            |        |                                                                                                                                                                                        |          |              |       |    |       |    |
| 30·00         | 62           |        |         |            |        |                                                                                                                                                                                        |          |              |       |    |       |    |
| 24            | "            | 420    | —       | —          | 0·6    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 25            | "            | 438    | —       | —          | 1·4    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 26            | "            | 420    | —       | —          | 0·6    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 27            | "            | 432    | —       | —          | 0·4    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 28            | "            | 407    | —       | Yes.       | —      |                                                                                                                                                                                        |          |              |       |    |       |    |
| 29            | "            | 433    | —       | —          | 0·8    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 30            | "            | 440    | —       | —          | 0·8    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 31            | "            | 414    | —       | Yes.       | —      |                                                                                                                                                                                        |          |              |       |    |       |    |
| 32            | "            | 437    | —       | Yes.       | —      |                                                                                                                                                                                        |          |              |       |    |       |    |
| 33            | "            | 435    | —       | —          | 0·8    | The vent stopper required oil; seemed difficult to work, and caused delay.                                                                                                             |          |              |       |    |       |    |
| 34            | "            | 435    | —       | —          | 0·8    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 35            | "            | 433    | —       | —          | 1·2    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 36            | "            | 434    | —       | —          | 1·0    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 37            | "            | 443    | —       | —          | 1·4    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 38            | "            | 413    | —       | —          | 0·8    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 39            | "            | 416    | —       | —          | 0·6    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 40            | "            | 436    | —       | —          | 0·8    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 41            | "            | 438    | —       | —          | 1·0    | The wedge flew out a little, and the lock-pin got out of order and was removed; and on examination the brass cover was found bent and cracked to an extent to render it unserviceable. |          |              |       |    |       |    |
| 42            | "            | 417    | —       | —          | 0·6    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 43            | "            | 421    | —       | —          | 0·6    | The practice was continued without it.                                                                                                                                                 |          |              |       |    |       |    |
| 44            | "            | 434    | —       | —          | 0·8    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 45            | "            | 436    | —       | —          | 0·6    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 46            | "            | 419    | —       | —          | 0·6    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 47            | "            | 435    | —       | —          | 0·4    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 48            | "            | 432    | —       | —          | 0·6    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 49            | "            | 449    | —       | —          | 0·2    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 50            | "            | 446    | —       | —          | 0·8    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 51            | "            | 421    | —       | —          | 0·8    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 52            | "            | 430    | —       | —          | 0·4    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 53            | "            | 430    | —       | —          | 0·6    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 54            | "            | 438    | —       | —          | 0·2    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 55            | "            | 434    | —       | —          | 0·4    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 56            | "            | 431    | —       | —          | 0·4    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 57            | "            | 449    | —       | —          | 0·8    |                                                                                                                                                                                        |          |              |       |    |       |    |
| 58            | "            | 434    | —       | Yes.       | —      |                                                                                                                                                                                        |          |              |       |    |       |    |

## RANGE AND ACCURACY.—SHOT—continued.

| No. of Round.  | Elevation.   | Range. | Recoil. | 1st Graze. |        | Remarks.                                                                                                              |          |              |       |    |
|----------------|--------------|--------|---------|------------|--------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|                |              |        |         | In Line.   | Right. |                                                                                                                       |          |              |       |    |
|                | °            | Yards. | Ft. In. |            | Yards. | June 13, 1864.                                                                                                        |          |              |       |    |
| 1              | 3            | 1,420  | —       | —          | 4.4    |                                                                                                                       |          |              |       |    |
| 2              | "            | 1,391  | —       | —          | 3.6    |                                                                                                                       |          |              |       |    |
| 3              | "            | 1,406  | —       | —          | 4.0    |                                                                                                                       |          |              |       |    |
| 4              | "            | 1,416  | —       | —          | 3.6    | The gun was on the line.                                                                                              |          |              |       |    |
| 5              | "            | 1,418  | —       | —          | 3.2    |                                                                                                                       |          |              |       |    |
| 6              | "            | 1,376  | —       | —          | 4.2    | Weather :—Hazy and raining, 10 a.m.                                                                                   |          |              |       |    |
| 7              | "            | 1,390  | —       | —          | 3.2    | Clear, 3 p.m.                                                                                                         |          |              |       |    |
| 8              | "            | 1,440  | —       | —          | 2.4    |                                                                                                                       |          |              |       |    |
| 9              | "            | 1,402  | —       | —          | 3.0    | Wind :—Direction, S.E. by S. ; force, 2 ; 10 a.m.                                                                     |          |              |       |    |
| 10             | "            | 1,422  | —       | —          | 3.6    | " " " 2 ; 3 p.m.                                                                                                      |          |              |       |    |
| 11             | "            | 1,432  | —       | —          | 2.2    |                                                                                                                       |          |              |       |    |
| 12             | "            | 1,434  | —       | —          | 2.0    | Thermometer :—60 dry, 57 wet, 10 a.m.                                                                                 |          |              |       |    |
| 13             | "            | 1,420  | —       | —          | 3.2    | 61 " 59 " 3 p.m.                                                                                                      |          |              |       |    |
| 14             | "            | 1,410  | —       | —          | 3.0    |                                                                                                                       |          |              |       |    |
| 15             | "            | 1,445  | —       | —          | 3.4    |                                                                                                                       |          |              |       |    |
| 16             | "            | 1,392  | —       | —          | 3.4    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.75</td><td>62</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.75 | 62 |
| Reading.       | Temperature. |        |         |            |        |                                                                                                                       |          |              |       |    |
| 29.75          | 62           |        |         |            |        |                                                                                                                       |          |              |       |    |
| 17             | "            | 1,400  | —       | —          | 3.2    | 29.70 62 3 p.m.                                                                                                       |          |              |       |    |
| 18             | "            | 1,382  | —       | —          | 3.4    |                                                                                                                       |          |              |       |    |
| 19             | "            | 1,376  | —       | —          | 3.0    |                                                                                                                       |          |              |       |    |
| 20             | "            | 1,385  | —       | —          | 1.8    |                                                                                                                       |          |              |       |    |
| 21             | "            | 1,362  | —       | —          | 2.6    |                                                                                                                       |          |              |       |    |
| 22             | "            | 1,350  | —       | —          | 2.2    |                                                                                                                       |          |              |       |    |
| 23             | "            | 1,348  | —       | —          | 5.0    |                                                                                                                       |          |              |       |    |
| June 14, 1864. |              |        |         |            |        |                                                                                                                       |          |              |       |    |
| 1              | 3            | 1,324  | —       | —          | 3.8    |                                                                                                                       |          |              |       |    |
| 2              | "            | 1,348  | —       | —          | 3.4    |                                                                                                                       |          |              |       |    |
| 3              | "            | 1,387  | —       | —          | 2.2    |                                                                                                                       |          |              |       |    |
| 4              | "            | 1,447  | —       | —          | 3.6    |                                                                                                                       |          |              |       |    |
| 5              | "            | 1,425  | —       | —          | 3.8    | 5th round struck out, to correspond with No. 5,                                                                       |          |              |       |    |
| 6              | "            | 1,402  | —       | —          | 3.8    | Whitworth, not seen.                                                                                                  |          |              |       |    |
| 7              | "            | 1,392  | —       | —          | 4.4    |                                                                                                                       |          |              |       |    |
| 8              | "            | 1,395  | —       | —          | 2.6    |                                                                                                                       |          |              |       |    |
| 9              | "            | 1,394  | —       | —          | 2.8    |                                                                                                                       |          |              |       |    |
| 10             | "            | 1,390  | —       | —          | 3.2    |                                                                                                                       |          |              |       |    |
| 11             | "            | 1,442  | —       | —          | 5.6    | The gun was on the line.                                                                                              |          |              |       |    |
| 12             | "            | 1,393  | —       | —          | 3.2    |                                                                                                                       |          |              |       |    |
| 13             | "            | 1,398  | —       | —          | 4.2    | Weather :—Clear.                                                                                                      |          |              |       |    |
| 14             | "            | 1,425  | —       | —          | 5.2    |                                                                                                                       |          |              |       |    |
| 15             | "            | 1,444  | —       | —          | 1.8    | Wind :—Direction, S.E. by S. ; force, 3 ; 10 a.m.                                                                     |          |              |       |    |
| 16             | "            | 1,405  | —       | —          | 2.6    | " S.W. by W. ; " 4 ; 3 p.m.                                                                                           |          |              |       |    |
| 17             | "            | 1,449  | —       | —          | 1.2    |                                                                                                                       |          |              |       |    |
| 18             | "            | 1,413  | —       | —          | 2.6    | Thermometer :—64 dry, 59 wet, 10 a.m.                                                                                 |          |              |       |    |
| 19             | "            | 1,400  | —       | —          | 1.8    | 68 " 63 " 3 p.m.                                                                                                      |          |              |       |    |
| 20             | "            | 1,399  | —       | —          | 4.0    |                                                                                                                       |          |              |       |    |
| 21             | "            | 1,407  | —       | —          | 1.6    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.70</td><td>63</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.70 | 63 |
| Reading.       | Temperature. |        |         |            |        |                                                                                                                       |          |              |       |    |
| 29.70          | 63           |        |         |            |        |                                                                                                                       |          |              |       |    |
| 22             | "            | 1,390  | —       | —          | 1.2    | 29.60 65 3 p.m.                                                                                                       |          |              |       |    |
| 23             | "            | 1,333  | —       | —          | 3.4    |                                                                                                                       |          |              |       |    |
| 24             | "            | 1,398  | —       | —          | 3.8    |                                                                                                                       |          |              |       |    |
| 25             | "            | 1,394  | —       | —          | 3.8    |                                                                                                                       |          |              |       |    |
| 26             | "            | 1,409  | —       | —          | 2.6    |                                                                                                                       |          |              |       |    |
| 27             | "            | 1,410  | —       | —          | 5.6    |                                                                                                                       |          |              |       |    |
| 28             | "            | 1,415  | —       | —          | 4.4    |                                                                                                                       |          |              |       |    |
| 29             | "            | 1,397  | —       | —          | 3.6    |                                                                                                                       |          |              |       |    |
| 30             | "            | 1,421  | —       | —          | 6.4    |                                                                                                                       |          |              |       |    |
| 31             | "            | 1,419  | —       | —          | 5.8    |                                                                                                                       |          |              |       |    |
| June 15, 1864. |              |        |         |            |        |                                                                                                                       |          |              |       |    |
| 1              | 3            | 1,446  | —       | —          | 4.2    | The gun was on the line.                                                                                              |          |              |       |    |
| 2              | "            | 1,496  | —       | —          | 4.0    | Weather :—Cloudy, 10 a.m.                                                                                             |          |              |       |    |
| 3              | "            | 1,465  | —       | —          | 5.6    | Rain, 3 p.m.                                                                                                          |          |              |       |    |
| 4              | "            | 1,468  | —       | —          | 6.2    |                                                                                                                       |          |              |       |    |
| 5              | "            | 1,487  | —       | —          | 4.4    | Wind :—Direction, N.W. by N. ; force, 6 ; 10 a.m.                                                                     |          |              |       |    |
| 6              | "            | 1,453  | —       | —          | 3.8    | " S.W. by W. ; " 3 ; 3 p.m.                                                                                           |          |              |       |    |
| 7              | "            | 1,448  | —       | —          | 5.2    | Thermometer :—61 dry, 56 wet, 10 a.m.                                                                                 |          |              |       |    |
| 8              | "            | 1,500  | —       | —          | 6.6    | 60 " 56 " 3 p.m.                                                                                                      |          |              |       |    |
| 9              | "            | 1,483  | —       | —          | 5.8    |                                                                                                                       |          |              |       |    |
| 10             | "            | 1,453  | —       | —          | 6.4    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.70</td><td>62</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.70 | 62 |
| Reading.       | Temperature. |        |         |            |        |                                                                                                                       |          |              |       |    |
| 29.70          | 62           |        |         |            |        |                                                                                                                       |          |              |       |    |
| 11             | "            | 1,425  | —       | —          | 3.2    | 29.70 62 3 p.m.                                                                                                       |          |              |       |    |



## RANGE AND ACCURACY.—SHOT—continued.

| No. of Round. | Elevation.   | Range. | Recoil.           | 1st Graze. |        | Remarks.                                                                                                                                                          |          |              |       |    |       |    |
|---------------|--------------|--------|-------------------|------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        |                   | In Line.   | Right. |                                                                                                                                                                   |          |              |       |    |       |    |
|               | °            | Yards. | Ft. In.           |            | Yards. |                                                                                                                                                                   |          |              |       |    |       |    |
| 1             | 6            | 2,396  | —                 | —          | 14.8   | June 15, 1864.<br><br>The gun was on the line.                                                                                                                    |          |              |       |    |       |    |
| 2             | "            | 2,482  | —                 | —          | 18.0   |                                                                                                                                                                   |          |              |       |    |       |    |
| 3             | "            | 2,417  | —                 | —          | 13.0   |                                                                                                                                                                   |          |              |       |    |       |    |
| 4             | "            | 2,408  | —                 | —          | 10.2   |                                                                                                                                                                   |          |              |       |    |       |    |
| 5             | "            | 2,447  | —                 | —          | 10.8   |                                                                                                                                                                   |          |              |       |    |       |    |
| 6             | "            | 2,481  | —                 | —          | 10.8   |                                                                                                                                                                   |          |              |       |    |       |    |
|               |              |        |                   |            |        | June 16, 1864.                                                                                                                                                    |          |              |       |    |       |    |
| 1             | 6            | 2,438  | 4 9               | —          | 13.4   | The gun was on the line.                                                                                                                                          |          |              |       |    |       |    |
| 2             | "            | 2,466  | 4 9               | —          | 10.0   |                                                                                                                                                                   |          |              |       |    |       |    |
| 3             | "            | 2,405  | 4 4 $\frac{1}{2}$ | —          | 13.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 4             | "            | 2,418  | 4 4 $\frac{1}{2}$ | —          | 16.8   |                                                                                                                                                                   |          |              |       |    |       |    |
| 5             | "            | 2,440  | 4 6               | —          | 16.2   |                                                                                                                                                                   |          |              |       |    |       |    |
| 6             | "            | 2,468  | 4 7 $\frac{1}{2}$ | —          | 14.6   |                                                                                                                                                                   |          |              |       |    |       |    |
| 7             | "            | 2,464  | 4 6               | —          | 17.2   | Weather :—Hazy, 10 a.m.<br>Clearing up, 3 p.m.                                                                                                                    |          |              |       |    |       |    |
| 8             | "            | 2,454  | 4 2               | —          | 18.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 9             | "            | 2,455  | 4 5               | —          | 18.0   | Wind :—Direction, S. by W. ; force, 5 ; 10 a.m.<br>" " " 4 ; 3 p.m.                                                                                               |          |              |       |    |       |    |
| 10            | "            | 2,464  | 4 4               | —          | 17.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 11            | "            | 2,484  | —                 | —          | 15.4   | Thermometer :—56 dry, 54 wet, 10 a.m.<br>58 " 56 " 3 p.m.                                                                                                         |          |              |       |    |       |    |
| 12            | "            | 2,418  | —                 | —          | 13.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 13            | "            | 2,400  | —                 | —          | 13.2   | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.75</td><td>58</td></tr><tr><td>29.80</td><td>60</td></tr></table> 10 a.m.<br>3 p.m. | Reading. | Temperature. | 29.75 | 58 | 29.80 | 60 |
| Reading.      | Temperature. |        |                   |            |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 29.75         | 58           |        |                   |            |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 29.80         | 60           |        |                   |            |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 14            | "            | 2,414  | —                 | —          | 14.0   |                                                                                                                                                                   |          |              |       |    |       |    |
| 15            | "            | 2,417  | —                 | —          | 13.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 16            | "            | 2,404  | —                 | —          | 12.0   |                                                                                                                                                                   |          |              |       |    |       |    |
| 17            | "            | 2,386  | —                 | —          | 14.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 18            | "            | 2,414  | —                 | —          | 11.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 19            | "            | 2,405  | —                 | —          | 12.6   |                                                                                                                                                                   |          |              |       |    |       |    |
| 20            | "            | 2,427  | —                 | —          | 13.6   |                                                                                                                                                                   |          |              |       |    |       |    |
| 21            | "            | 2,419  | —                 | —          | 14.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 22            | "            | 2,408  | —                 | —          | 11.2   |                                                                                                                                                                   |          |              |       |    |       |    |
| 23            | "            | 2,396  | —                 | —          | 11.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 24            | "            | 2,400  | —                 | —          | 14.2   |                                                                                                                                                                   |          |              |       |    |       |    |
| 25            | "            | 2,392  | —                 | —          | 18.0   |                                                                                                                                                                   |          |              |       |    |       |    |
| 26            | "            | 2,409  | —                 | —          | 12.2   |                                                                                                                                                                   |          |              |       |    |       |    |
| 27            | "            | 2,401  | —                 | —          | 12.0   |                                                                                                                                                                   |          |              |       |    |       |    |
| 28            | "            | 2,390  | —                 | —          | 16.4   |                                                                                                                                                                   |          |              |       |    |       |    |
|               |              |        |                   |            |        | June 27, 1864.                                                                                                                                                    |          |              |       |    |       |    |
| 1             | 6            | 2,384  | —                 | —          | 22.2   | The gun was on the line.                                                                                                                                          |          |              |       |    |       |    |
| 2             | "            | 2,347  | —                 | —          | 23.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 3             | "            | 2,396  | —                 | —          | 22.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 4             | "            | 2,391  | —                 | —          | 22.8   |                                                                                                                                                                   |          |              |       |    |       |    |
| 5             | "            | 2,380  | —                 | —          | 21.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 6             | "            | 2,411  | —                 | —          | 23.6   | Weather :—Cloudy, 10 a.m.<br>" 3 p.m.                                                                                                                             |          |              |       |    |       |    |
| 7             | "            | 2,423  | —                 | —          | 22.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 8             | "            | 2,355  | —                 | —          | 24.0   | Wind :—Direction, N.N.W. ; force, 4 ; 10 a.m.<br>" " " 3 ; 3 p.m.                                                                                                 |          |              |       |    |       |    |
| 9             | "            | 2,343  | —                 | —          | 25.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 10            | "            | 2,390  | —                 | —          | 22.6   | Thermometer :—61 dry, 55 wet, 10 a.m.<br>61 " 57 " 3 p.m.                                                                                                         |          |              |       |    |       |    |
| 11            | "            | 2,394  | —                 | —          | 21.2   |                                                                                                                                                                   |          |              |       |    |       |    |
| 12            | "            | 2,433  | —                 | —          | 26.4   | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.10</td><td>59</td></tr><tr><td>30.15</td><td>59</td></tr></table> 10 a.m.<br>3 p.m. | Reading. | Temperature. | 30.10 | 59 | 30.15 | 59 |
| Reading.      | Temperature. |        |                   |            |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 30.10         | 59           |        |                   |            |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 30.15         | 59           |        |                   |            |        |                                                                                                                                                                   |          |              |       |    |       |    |
| 13            | "            | 2,364  | —                 | —          | 24.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 14            | "            | 2,290  | —                 | —          | 22.6   |                                                                                                                                                                   |          |              |       |    |       |    |
| 15            | "            | 2,367  | —                 | —          | 22.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 16            | "            | 2,390  | —                 | —          | 22.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 17            | "            | 2,411  | —                 | —          | 21.0   |                                                                                                                                                                   |          |              |       |    |       |    |
| 18            | "            | 2,382  | —                 | —          | 20.6   |                                                                                                                                                                   |          |              |       |    |       |    |
| 19            | "            | 2,370  | —                 | —          | 21.2   |                                                                                                                                                                   |          |              |       |    |       |    |
| 20            | "            | 2,385  | —                 | —          | 23.2   |                                                                                                                                                                   |          |              |       |    |       |    |
| 21            | "            | 2,340  | —                 | —          | 23.8   |                                                                                                                                                                   |          |              |       |    |       |    |
| 22            | "            | 2,344  | —                 | —          | 24.0   |                                                                                                                                                                   |          |              |       |    |       |    |
| 23            | "            | 2,346  | —                 | —          | 21.6   |                                                                                                                                                                   |          |              |       |    |       |    |
| 24            | "            | 2,365  | —                 | —          | 22.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 25            | "            | 2,384  | —                 | —          | 19.2   |                                                                                                                                                                   |          |              |       |    |       |    |
| 26            | "            | 2,310  | —                 | —          | 25.4   |                                                                                                                                                                   |          |              |       |    |       |    |
| 27            | "            | 2,413  | —                 | —          | 22.8   |                                                                                                                                                                   |          |              |       |    |       |    |
| 28            | "            | 2,404  | —                 | —          | 24.6   |                                                                                                                                                                   |          |              |       |    |       |    |
| 29            | "            | 2,309  | —                 | —          | 26.6   |                                                                                                                                                                   |          |              |       |    |       |    |
| 30            | "            | 2,423  | —                 | —          | 22.6   |                                                                                                                                                                   |          |              |       |    |       |    |
| 31            | "            | 2,406  | —                 | —          | 26.0   |                                                                                                                                                                   |          |              |       |    |       |    |
| 32            | "            | 2,407  | —                 | —          | 25.6   |                                                                                                                                                                   |          |              |       |    |       |    |

RANGE AND ACCURACY.—SHOT—*continued.*

| No. of Round. | Elevation. | Range. | 1st Graze. |        | Remarks.                                                                                  |
|---------------|------------|--------|------------|--------|-------------------------------------------------------------------------------------------|
|               |            |        | In Line.   | Right. |                                                                                           |
|               | °          | Yards. |            | Yards. |                                                                                           |
| 1             | 9          | 3,331  | —          | 18.0   | July 11, 1864.<br><br>The gun was on the line.<br>Weather :—Very slight haze, 10 a.m.<br> |

## RANGE AND ACCURACY.—SHOT—continued.

| No. of Round. | Elevation. | Range. | 1st Graze. |        | Remarks.                                                                  |
|---------------|------------|--------|------------|--------|---------------------------------------------------------------------------|
|               |            |        | In Line.   | Right. |                                                                           |
|               | °          | Yards. |            | Yards. |                                                                           |
| 1             | 17         | 5,048  | —          | 72·6   | July 13, 1864.                                                            |
| 2             | "          | 5,190  | —          | 69·0   |                                                                           |
| 3             | "          | 5,170  | —          | 80·4   |                                                                           |
| 4             | "          | 5,150  | —          | 88·6   |                                                                           |
| 5             | "          | 5,168  | —          | 82·6   |                                                                           |
| 6             | "          | 5,108  | —          | 80·8   | The gun was 10 feet right of line.                                        |
| 7             | "          | 5,100  | —          | 73·4   |                                                                           |
| 8             | "          | 5,139  | —          | 72·8   | Weather :—Clear, 10 a.m.                                                  |
| 9             | "          | 5,154  | —          | 71·8   | " 3 p.m.                                                                  |
| 10            | "          | 4,900  | —          | 62·0   |                                                                           |
| 11            | "          | 5,150  | —          | 64·6   | Wind :—Direction, N.E. by E. ; force, 4 ; 10 a.m.                         |
| 12            | "          | 5,106  | —          | 61·4   | " E. by S. " 5 ; 3 p.m.                                                   |
| 13            | "          | 5,075  | —          | 51·8   |                                                                           |
| 14            | "          | 5,054  | —          | 64·4   | Thermometer :—62 dry, 60 wet, 10 a.m.                                     |
| 15            | "          | 5,125  | —          | 62·8   | 65 " 62 " 3 p.m.                                                          |
| 16            | "          | 5,059  | —          | 59·8   |                                                                           |
| 17            | "          | 5,095  | —          | 71·8   |                                                                           |
| 18            | "          | 5,050  | —          | 68·6   | Barometer :— <sup>Reading.</sup> 30·05 <sup>Temperature.</sup> 65 10 a.m. |
| 19            | "          | 5,038  | —          | 58·6   | 30·10 60 3 p.m.                                                           |
| 20            | "          | 5,006  | —          | 59·4   |                                                                           |
| 21            | "          | 4,996  | —          | 59·0   |                                                                           |
| 22            | "          | 5,015  | —          | 51·4   |                                                                           |
| 1             | 19         | 5,450  | —          | 70·0   |                                                                           |
| 2             | "          | 5,565  | —          | 78·6   |                                                                           |
| 3             | "          | 5,575  | —          | 76·8   |                                                                           |
| 4             | "          | 5,500  | —          | 78·4   |                                                                           |
| 5             | "          | 5,492  | —          | 79·8   |                                                                           |
| 6             | "          | 5,480  | —          | 75·6   | The gun was 10 feet right of line.                                        |
| 7             | "          | 5,470  | —          | 78·8   |                                                                           |
| 8             | "          | 5,464  | —          | 76·6   |                                                                           |
| 9             | "          | 5,496  | —          | 73·8   |                                                                           |
| 10            | "          | 5,500  | —          | 72·6   |                                                                           |
| 11            | "          | 5,499  | —          | 70·4   |                                                                           |
| 1             | 19         | 5,494  | —          | 65·8   | July 14, 1864.                                                            |
| 2             | "          | 5,520  | —          | 65·0   |                                                                           |
| 3             | "          | 5,609  | —          | 60·2   |                                                                           |
| 4             | "          | 5,606  | —          | 64·4   |                                                                           |
| 5             | "          | 5,416  | —          | 49·8   |                                                                           |
| 6             | "          | 5,570  | —          | 63·4   | The gun was 10 feet right of line.                                        |
| 7             | "          | 5,461  | —          | 61·4   |                                                                           |
| 8             | "          | 5,622  | —          | 60·8   |                                                                           |
| 9             | "          | 5,554  | —          | 55·0   |                                                                           |
| 10            | "          | 5,547  | —          | 61·4   |                                                                           |
| 11            | "          | 5,484  | —          | 53·2   |                                                                           |
| 12            | "          | 5,508  | —          | 52·4   |                                                                           |
| 1             | 21         | 6,040  | —          | 88·4   | July 14, 1864.                                                            |
| 2             | "          | 5,987  | —          | 85·2   |                                                                           |
| 3             | "          | 5,899  | —          | 81·8   |                                                                           |
| 4             | "          | 5,901  | —          | 85·0   |                                                                           |
| 5             | "          | 5,964  | —          | 80·0   |                                                                           |
| 6             | "          | 5,887  | —          | 85·4   | The gun was 10 feet right of line.                                        |
| 7             | "          | 6,096  | —          | 87·6   |                                                                           |
| 8             | "          | 5,848  | —          | 75·8   | Weather :—Clear, 10 a.m.                                                  |
| 9             | "          | 6,109  | —          | 76·4   | " 3 p.m.                                                                  |
| 10            | "          | 6,011  | —          | 83·0   |                                                                           |
| 11            | "          | 5,756  | —          | 75·4   |                                                                           |
| 12            | "          | 5,893  | —          | 71·2   | Wind :—Direction, E. by S. ; force, 5 ; 10 a.m.                           |
| 13            | "          | 5,803  | —          | 82·4   | " S.E. by S. " 2 ; 3 p.m.                                                 |
| 14            | "          | 6,005  | —          | 73·0   |                                                                           |
| 15            | "          | 5,944  | —          | 73·8   | Thermometer :—60 dry, 57 wet, 10 a.m.                                     |
| 16            | "          | 5,940  | —          | 77·2   | 67 " 63 " 3 p.m.                                                          |
| 17            | "          | 5,848  | —          | 71·6   |                                                                           |
| 18            | "          | 5,993  | —          | 81·4   | Barometer :— <sup>Reading.</sup> 30·20 <sup>Temperature.</sup> 63 10 a.m. |
| 19            | "          | 5,864  | —          | 78·0   | 30·22 62 3 p.m.                                                           |
| 20            | "          | 6,007  | —          | 74·6   |                                                                           |
| 21            | "          | 5,796  | —          | 70·8   |                                                                           |
| 22            | "          | 5,861  | —          | 86·0   |                                                                           |

RANGE AND ACCURACY.—SHOT—continued.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | In Line.   | Right. |                                                                                                                                                         |          |              |       |    |       |    |
|               | °            | Yards. |            | Yards. | September 22, 1864.                                                                                                                                     |          |              |       |    |       |    |
| 1             | 5            | 2,060  | —          | 26·0   |                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "            | 2,148  | —          | 24·0   |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 2,094  | —          | 26·0   | The gun was 10 feet right of line.                                                                                                                      |          |              |       |    |       |    |
| 4             | "            | 2,062  | —          | 30·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "            | 2,134  | —          | 18·4   | Some of these shot could not be rammed home, owing to the lead coating having been damaged.                                                             |          |              |       |    |       |    |
| 6             | "            | 2,070  | —          | 24·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 7             | "            | 2,098  | —          | 19·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 8             | "            | 2,066  | —          | 20·0   |                                                                                                                                                         |          |              |       |    |       |    |
| 9             | "            | 2,112  | —          | 20·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 10            | "            | 2,114  | —          | 22·0   | Not seen. Shot not rammed home.                                                                                                                         |          |              |       |    |       |    |
| 11            | "            | 2,086  | —          | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "            | 2,122  | —          | 20·0   |                                                                                                                                                         |          |              |       |    |       |    |
| 13            | "            | 2,120  | —          | 22·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 14            | "            | 2,052  | —          | 18·0   |                                                                                                                                                         |          |              |       |    |       |    |
| 15            | "            | 2,114  | —          | 16·2   |                                                                                                                                                         |          |              |       |    |       |    |
| 16            | "            | 2,105  | —          | 9·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 17            | "            | 2,074  | —          | 14·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 18            | "            | 2,040  | —          | 13·0   |                                                                                                                                                         |          |              |       |    |       |    |
| 19            | "            | 2,084  | —          | 16·0   |                                                                                                                                                         |          |              |       |    |       |    |
| 20            | "            | 2,080  | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 1             | 8            | 2,994  | —          | 9·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "            | 3,105  | —          | 9·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 3,102  | —          | 14·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "            | 3,044  | —          | 13·2   |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "            | 3,081  | —          | 10·0   |                                                                                                                                                         |          |              |       |    |       |    |
| 6             | "            | 3,021  | —          | 12·2   | The gun was 10 feet right of line.                                                                                                                      |          |              |       |    |       |    |
| 7             | "            | 2,784  | —          | 9·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 8             | "            | 3,086  | —          | 10·0   | Weather :—Clear.                                                                                                                                        |          |              |       |    |       |    |
| 9             | "            | 3,084  | —          | 18·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 10            | "            | 3,093  | —          | 12·2   | Wind :—Direction, S.W. by W. ; force, 3 ; 10 a.m.                                                                                                       |          |              |       |    |       |    |
| 11            | "            | —      | —          | 14·4   | "          W.S.W.          "          4 ; 3 p.m.                                                                                                        |          |              |       |    |       |    |
| 12            | "            | 2,918  | —          | 12·0   |                                                                                                                                                         |          |              |       |    |       |    |
| 13            | "            | 3,070  | —          | 10·4   | Thermometer :—61 dry, 58 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 14            | "            | 3,053  | —          | 10·0   | 67 " 59 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 15            | "            | 3,072  | —          | 9·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 16            | "            | 2,668  | —          | 8·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 17            | "            | 3,059  | —          | 11·0   | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29·85</td><td>61</td></tr><tr><td>29·85</td><td>64</td></tr></table> 10 a.m. | Reading. | Temperature. | 29·85 | 61 | 29·85 | 64 |
| Reading.      | Temperature. |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·85         | 61           |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·85         | 64           |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 18            | "            | 3,078  | —          | 10·6   | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 19            | "            | 3,065  | —          | 11·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 20            | "            | 3,110  | —          | 8·6    |                                                                                                                                                         |          |              |       |    |       |    |

RANGE AND ACCURACY—*continued*.

## COMMON SHELL (WEIGHTED WITH SAND).

## PARTICULARS OF SHELL AND AMMUNITION.

SHOEBURYNESSE.

Weight, 70 lbs.  
Diameter, 6·43 inches.Length, 14·66 inches.  
Bursting charge, 4 lbs. 13½ oz.

| No. of Round. | Elevation.   | Range. | 1st Graze. | Remarks.                                                                                                              |          |              |       |    |
|---------------|--------------|--------|------------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|               |              |        | Right.     |                                                                                                                       |          |              |       |    |
|               | °            | Yards. | Yards.     | September 7, 1864.                                                                                                    |          |              |       |    |
| 1             | 4            | 1,828  | 11·4       |                                                                                                                       |          |              |       |    |
| 2             | "            | 1,857  | 9·6        |                                                                                                                       |          |              |       |    |
| 3             | "            | 1,860  | 7·0        |                                                                                                                       |          |              |       |    |
| 4             | "            | 1,901  | 11·6       |                                                                                                                       |          |              |       |    |
| 5             | "            | 1,865  | 12·2       |                                                                                                                       |          |              |       |    |
| 6             | "            | 1,855  | 8·0        |                                                                                                                       |          |              |       |    |
| 7             | "            | 1,869  | 8·2        |                                                                                                                       |          |              |       |    |
| 8             | "            | 1,848  | 10·4       |                                                                                                                       |          |              |       |    |
| 9             | "            | 1,846  | 9·8        |                                                                                                                       |          |              |       |    |
| 10            | "            | 1,829  | 10·4       |                                                                                                                       |          |              |       |    |
| 11            | "            | 1,809  | 8·2        |                                                                                                                       |          |              |       |    |
| 12            | "            | 1,842  | 11·6       |                                                                                                                       |          |              |       |    |
| 13            | "            | 1,856  | 9·6        |                                                                                                                       |          |              |       |    |
| 14            | "            | 1,831  | 11·2       |                                                                                                                       |          |              |       |    |
| 15            | "            | 1,827  | 11·0       |                                                                                                                       |          |              |       |    |
| 16            | "            | 1,841  | 9·2        | The gun was 10 feet right of line.                                                                                    |          |              |       |    |
| 17            | "            | 1,828  | 9·4        |                                                                                                                       |          |              |       |    |
| 18            | "            | 1,833  | 9·0        | Weather :—Very hazy, 10 a.m.                                                                                          |          |              |       |    |
| 19            | "            | 1,866  | 11·4       | Hazy, 3 p.m.                                                                                                          |          |              |       |    |
| 20            | "            | 1,824  | 11·2       |                                                                                                                       |          |              |       |    |
| 21            | "            | 1,826  | 11·4       | Wind :—Direction, N.W. by W. ; force, 3 ; 10 a.m.                                                                     |          |              |       |    |
| 22            | "            | 1,766  | 10·8       | " " " 2 ; 3 p.m.                                                                                                      |          |              |       |    |
| 23            | "            | 1,835  | 10·4       |                                                                                                                       |          |              |       |    |
| 24            | "            | 1,843  | 10·8       | Thermometer :—67 dry, 66 wet, 10 a.m.                                                                                 |          |              |       |    |
| 25            | "            | 1,864  | 11·2       | 69 " 67 " 3 p.m.                                                                                                      |          |              |       |    |
| 26            | "            | 1,866  | 12·4       |                                                                                                                       |          |              |       |    |
| 27            | "            | 1,835  | 10·6       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·05</td><td>64</td></tr></table> 10 a.m. | Reading. | Temperature. | 30·05 | 64 |
| Reading.      | Temperature. |        |            |                                                                                                                       |          |              |       |    |
| 30·05         | 64           |        |            |                                                                                                                       |          |              |       |    |
| 28            | "            | 1,840  | 10·0       | <table><tr><td>30·05</td><td>66</td></tr></table> 3 p.m.                                                              | 30·05    | 66           |       |    |
| 30·05         | 66           |        |            |                                                                                                                       |          |              |       |    |
| 29            | "            | 1,866  | 13·8       |                                                                                                                       |          |              |       |    |
| 30            | "            | 1,824  | 13·4       |                                                                                                                       |          |              |       |    |
| 31            | "            | 1,796  | 12·4       |                                                                                                                       |          |              |       |    |
| 32            | "            | 1,851  | 11·4       |                                                                                                                       |          |              |       |    |
| 33            | "            | 1,788  | 13·4       |                                                                                                                       |          |              |       |    |
| 34            | "            | 1,811  | 13·0       |                                                                                                                       |          |              |       |    |
| 35            | "            | 1,788  | 11·2       |                                                                                                                       |          |              |       |    |
| 36            | "            | 1,851  | 11·4       |                                                                                                                       |          |              |       |    |
| 37            | "            | 1,813  | 12·6       |                                                                                                                       |          |              |       |    |
| 38            | "            | 1,834  | 12·0       |                                                                                                                       |          |              |       |    |
| 39            | "            | 1,802  | 13·6       |                                                                                                                       |          |              |       |    |
| 40            | "            | 1,894  | 13·2       |                                                                                                                       |          |              |       |    |
| 41            | "            | 1,844  | 9·2        |                                                                                                                       |          |              |       |    |



RANGE AND ACCURACY.—COMMON SHELL—continued.

| No of Round. | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                                                                       |          |              |       |    |       |    |
|--------------|--------------|--------|------------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|              |              |        |            | Right. |                                                                                                                                                                |          |              |       |    |       |    |
|              | °            | Yards. | Yards.     |        | September 9, 1864.                                                                                                                                             |          |              |       |    |       |    |
| 1            | 7            | 2,954  | 18.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 2            | "            | 2,963  | 9.4        |        |                                                                                                                                                                |          |              |       |    |       |    |
| 3            | "            | 2,990  | 10.8       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 4            | "            | 2,905  | 11.4       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 5            | "            | 3,020  | 15.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 6            | "            | 2,800  | 17.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 7            | "            | 2,990  | 15.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 8            | "            | 3,008  | 12.6       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 9            | "            | 2,940  | 14.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 10           | "            | 2,941  | 13.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 11           | "            | 2,988  | 9.0        |        |                                                                                                                                                                |          |              |       |    |       |    |
| 12           | "            | 2,924  | 19.2       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 13           | "            | 2,970  | 10.8       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 14           | "            | 2,994  | 15.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 15           | "            | 2,900  | 1.0        |        |                                                                                                                                                                |          |              |       |    |       |    |
| 16           | "            | 2,983  | 14.6       |        | The gun was 10 feet right of line.                                                                                                                             |          |              |       |    |       |    |
| 17           | "            | 2,985  | 12.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 18           | "            | 2,977  | 15.0       |        | Weather :—Clear, 10 a.m.<br>Slight haze, 3 p.m.                                                                                                                |          |              |       |    |       |    |
| 19           | "            | 2,903  | 11.6       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 20           | "            | 2,963  | 13.4       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 21           | "            | 2,945  | 9.6        |        | Wind :—Direction, W. ; force, 5 ; 10 a.m.<br>" " " 7 ; 3 p.m.                                                                                                  |          |              |       |    |       |    |
| 22           | "            | 2,935  | 14.4       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 23           | "            | 2,939  | 14.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 24           | "            | 2,866  | 3.0        |        | Thermometer :—68 dry, 65 wet, 10 a.m.<br>69 " 66 " 3 p.m.                                                                                                      |          |              |       |    |       |    |
| 25           | "            | 2,919  | 13.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 26           | "            | 2,952  | 14.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 27           | "            | 2,941  | 14.0       |        | Barometer <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.05</td><td>66</td></tr><tr><td>29.95</td><td>67</td></tr></table> 10 a.m.<br>3 p.m. | Reading. | Temperature. | 30.05 | 66 | 29.95 | 67 |
| Reading.     | Temperature. |        |            |        |                                                                                                                                                                |          |              |       |    |       |    |
| 30.05        | 66           |        |            |        |                                                                                                                                                                |          |              |       |    |       |    |
| 29.95        | 67           |        |            |        |                                                                                                                                                                |          |              |       |    |       |    |
| 28           | "            | 2,931  | 11.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 29           | "            | 2,930  | 6.4        |        |                                                                                                                                                                |          |              |       |    |       |    |
| 30           | "            | 2,920  | 11.2       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 31           | "            | 2,918  | 13.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 32           | "            | 2,930  | 14.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 33           | "            | 2,974  | 12.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 34           | "            | 2,937  | 13.2       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 35           | "            | 2,955  | 12.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 36           | "            | 2,978  | 9.0        |        |                                                                                                                                                                |          |              |       |    |       |    |
| 37           | "            | 2,950  | 8.0        |        |                                                                                                                                                                |          |              |       |    |       |    |
| 38           | "            | 2,925  | 10.0       |        |                                                                                                                                                                |          |              |       |    |       |    |
| 39           | "            | 2,877  | 9.0        |        |                                                                                                                                                                |          |              |       |    |       |    |
| 40           | "            | 2,908  | 7.0        |        |                                                                                                                                                                |          |              |       |    |       |    |
| 41           | "            | 2,850  | 7.8        |        |                                                                                                                                                                |          |              |       |    |       |    |
| 42           | "            | 2,907  | 1.2        |        |                                                                                                                                                                |          |              |       |    |       |    |
| 43           | "            | 2,912  | 5.0        |        |                                                                                                                                                                |          |              |       |    |       |    |
| 44           | "            | 2,899  | 11.2       |        |                                                                                                                                                                |          |              |       |    |       |    |



## RANGE AND ACCURACY—continued.

## SEGMENT SHELL.

## PARTICULARS OF SHELL AND AMMUNITION.

SHOEBURYNESS.

Weight, 75 lbs.  
Diameter, 6·43 inches.  
Length, 13·85 inches.

No. of segments, 112.  
Bursting charge, 3 lbs.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | Right.     | Left.  |                                                                                                                                                         |          |              |       |    |       |    |
|               | °            | Yards. | Yards.     | Yards. | June 30, 1864.                                                                                                                                          |          |              |       |    |       |    |
| 1             | 2            | 1,102  | 4·2        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "            | 1,050  | 4·0        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 1,098  | 3·4        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "            | 1,059  | 3·6        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "            | 1,053  | 3·2        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 6             | "            | 1,048  | 3·6        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 7             | "            | 1,038  | 4·2        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 8             | "            | 1,052  | 2·8        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 9             | "            | 1,034  | 3·4        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 10            | "            | 1,061  | 4·4        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 11            | "            | 1,054  | 3·8        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "            | 1,048  | 5·6        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 13            | "            | 1,044  | 2·8        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 14            | "            | 1,042  | 3·6        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 15            | "            | 1,064  | 3·2        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 16            | "            | 1,062  | 3·0        | —      | The gun was on the line.                                                                                                                                |          |              |       |    |       |    |
| 17            | "            | 1,054  | 3·2        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 18            | "            | 1,042  | 2·6        | —      | Weather :—Clear, 10 a.m.                                                                                                                                |          |              |       |    |       |    |
| 19            | "            | 1,037  | 2·4        | —      | " Slight haze, 3 p.m.                                                                                                                                   |          |              |       |    |       |    |
| 20            | "            | 1,050  | 2·0        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 21            | "            | 1,048  | 2·6        | —      | Wind :—Direction, N.W. by N. ; force, 5 ; 10 a.m.                                                                                                       |          |              |       |    |       |    |
| 22            | "            | 1,098  | 2·0        | —      | " " " 4 ; 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 23            | "            | 1,100  | 3·2        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 24            | "            | 1,092  | 3·0        | —      | Thermometer :—63 dry, 60 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 25            | "            | 1,064  | 3·6        | —      | 68 " 62 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 26            | "            | 1,098  | 3·2        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 27            | "            | 1,100  | 2·4        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 28            | "            | 1,080  | 2·6        | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29·95</td><td>61</td></tr><tr><td>29·95</td><td>64</td></tr></table> 10 a.m. | Reading. | Temperature. | 29·95 | 61 | 29·95 | 64 |
| Reading.      | Temperature. |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·95         | 61           |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·95         | 64           |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29            | "            | 1,170  | 4·4        | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 30            | "            | 1,142  | 1·6        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 31            | "            | 1,015  | 4·6        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 32            | "            | 1,032  | 1·6        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 33            | "            | 1,032  | 1·6        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 34            | "            | 1,018  | 2·4        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 35            | "            | 1,005  | 3·4        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 36            | "            | 1,020  | 4·0        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 37            | "            | 1,034  | 3·4        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 38            | "            | 1,058  | 3·2        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 39            | "            | 1,050  | 2·2        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 40            | "            | 996    | 2·0        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 41            | "            | 1,052  | 3·4        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 42            | "            | 1,090  | 4·0        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 43            | "            | 1,100  | 4·0        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 44            | "            | 1,086  | 4·2        | —      |                                                                                                                                                         |          |              |       |    |       |    |

RANGE AND ACCURACY.—SEGMENT SHELL—continued.

| No. of Rounds. | Elevation. | Range. | 1st Graze. |        | Remarks.                                      |
|----------------|------------|--------|------------|--------|-----------------------------------------------|
|                |            |        | Right.     | Left.  |                                               |
|                | °          | Yards. | Yards.     | Yards. | July 1, 1864.                                 |
| 1              | 5          | 2,090  | 12.4       | —      |                                               |
| 2              | "          | 2,060  | 14.6       | —      |                                               |
| 3              | "          | 2,108  | 13.6       | —      |                                               |
| 4              | "          | 2,031  | 12.4       | —      |                                               |
| 5              | "          | 2,098  | 13.4       | —      |                                               |
| 6              | "          | 2,094  | 13.2       | —      |                                               |
| 7              | "          | 2,110  | 14.4       | —      |                                               |
| 8              | "          | 2,017  | 12.6       | —      |                                               |
| 9              | "          | 2,005  | 11.6       | —      |                                               |
| 10             | "          | 2,090  | 13.4       | —      |                                               |
| 11             | "          | 2,080  | 14.0       | —      |                                               |
| 12             | "          | 2,067  | 11.8       | —      |                                               |
| 13             | "          | 1,985  | 12.6       | —      |                                               |
| 14             | "          | 2,071  | 12.8       | —      |                                               |
| 15             | "          | 1,881  | 12.4       | —      |                                               |
| 16             | "          | 2,060  | 7.6        | —      | The gun was on the line.                      |
| 17             | "          | 2,050  | 14.4       | —      |                                               |
| 18             | "          | 2,049  | 12.6       | —      | Weather :—Clear, 10 a.m.                      |
| 19             | "          | 1,940  | 9.4        | —      | Slight haze, 3 p.m.                           |
| 20             | "          | 1,957  | 10.4       | —      |                                               |
| 21             | "          | 1,881  | 10.0       | —      | Wind :—Direction, N.N.W. ; force, 4 ; 10 a.m. |
| 22             | "          | 1,940  | 9.6        | —      | " " " " N.W. " 4 ; 3 p.m.                     |
| 23             | "          | 1,906  | 10.0       | —      |                                               |
| 24             | "          | 1,920  | 10.6       | —      | Thermometer :—60 dry, 56 wet, 10 a.m.         |
| 25             | "          | 1,948  | 9.8        | —      | 67 " 60 " 3 p.m.                              |
| 26             | "          | 1,848  | 10.4       | —      |                                               |
| 27             | "          | 1,950  | 10.2       | —      |                                               |
| 28             | "          | 2,025  | 14.4       | —      |                                               |
| 29             | "          | 2,085  | 12.6       | —      |                                               |
| 30             | "          | 2,000  | 12.0       | —      |                                               |
| 31             | "          | 1,969  | 11.6       | —      |                                               |
| 32             | "          | 1,934  | 6.6        | —      |                                               |
| 33             | "          | 2,002  | 10.6       | —      |                                               |
| 34             | "          | 1,933  | 12.6       | —      |                                               |
| 35             | "          | 1,921  | 12.4       | —      |                                               |
| 36             | "          | 1,924  | 10.6       | —      |                                               |
| 37             | "          | 2,048  | 12.4       | —      |                                               |
| 38             | "          | 1,922  | 10.4       | —      |                                               |
| 39             | "          | 1,900  | 10.4       | —      |                                               |
| 40             | "          | 1,943  | 15.4       | —      |                                               |
| 41             | "          | 1,949  | 11.6       | —      |                                               |
| 42             | "          | 1,823  | 10.8       | —      |                                               |
| 43             | "          | 1,832  | 12.8       | —      |                                               |
| 44             | "          | 1,930  | 11.6       | —      |                                               |

RANGE AND ACCURACY.—SEGMENT SHELL—*continued.*

| No. of Round. | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                              |          |              |       |    |
|---------------|--------------|--------|------------|--------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|               |              |        | Right.     | Left.  |                                                                                                                       |          |              |       |    |
|               | °            | Yards. | Yards.     | Yards. | September 13, 1864.                                                                                                   |          |              |       |    |
| 1             | 8            | 3,024  | 14.4       | —      |                                                                                                                       |          |              |       |    |
| 2             | "            | 3,080  | 14.8       | —      |                                                                                                                       |          |              |       |    |
| 3             | "            | 3,024  | 15.6       | —      |                                                                                                                       |          |              |       |    |
| 4             | "            | 3,094  | 13.2       | —      |                                                                                                                       |          |              |       |    |
| 5             | "            | 3,081  | 14.4       | —      |                                                                                                                       |          |              |       |    |
| 6             | "            | 3,090  | 15.2       | —      |                                                                                                                       |          |              |       |    |
| 7             | "            | 3,080  | 13.6       | —      |                                                                                                                       |          |              |       |    |
| 8             | "            | 3,056  | 11.6       | —      |                                                                                                                       |          |              |       |    |
| 9             | "            | 3,246  | 11.2       | —      |                                                                                                                       |          |              |       |    |
| 10            | "            | 3,066  | 12.6       | —      |                                                                                                                       |          |              |       |    |
| 11            | "            | 2,918  | 10.8       | —      |                                                                                                                       |          |              |       |    |
| 12            | "            | 2,930  | 14.2       | —      |                                                                                                                       |          |              |       |    |
| 13            | "            | 3,004  | 14.0       | —      |                                                                                                                       |          |              |       |    |
| 14            | "            | 2,990  | 16.2       | —      |                                                                                                                       |          |              |       |    |
| 15            | "            | 2,944  | 17.0       | —      |                                                                                                                       |          |              |       |    |
| 16            | "            | 2,984  | 12.0       | —      | The gun was 10 feet right of line.                                                                                    |          |              |       |    |
| 17            | "            | 2,996  | 12.6       | —      |                                                                                                                       |          |              |       |    |
| 18            | "            | 3,010  | 11.0       | —      | Weather:—Clear.                                                                                                       |          |              |       |    |
| 19            | "            | 3,058  | 9.2        | —      |                                                                                                                       |          |              |       |    |
| 20            | "            | 2,994  | 10.6       | —      | Wind :—Direction :—W.S.W. ; force, 3 ; 10 a.m.                                                                        |          |              |       |    |
| 21            | "            | 3,026  | 8.4        | —      | "          S.W. by S.   "   5 ; 3 p.m.                                                                                |          |              |       |    |
| 22            | "            | 3,040  | 10.0       | —      |                                                                                                                       |          |              |       |    |
| 23            | "            | 3,025  | 10.0       | —      | Thermometer :—60 dry, 59 wet, 10 a.m.                                                                                 |          |              |       |    |
| 24            | "            | 2,891  | 8.0        | —      | 62   "   60   "   3 p.m.                                                                                              |          |              |       |    |
| 25            | "            | 3,181  | 3.4        | —      |                                                                                                                       |          |              |       |    |
| 26            | "            | 2,964  | 5.0        | —      |                                                                                                                       |          |              |       |    |
| 27            | "            | 2,962  | 9.4        | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.05</td><td>58</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.05 | 58 |
| Reading.      | Temperature. |        |            |        |                                                                                                                       |          |              |       |    |
| 30.05         | 58           |        |            |        |                                                                                                                       |          |              |       |    |
| 28            | "            | 3,027  | 7.4        | —      | 29.95       61       3 p.m.                                                                                           |          |              |       |    |
| 29            | "            | 2,466  | —          | 11.0   |                                                                                                                       |          |              |       |    |
| 30            | "            | 2,963  | 8.0        | —      |                                                                                                                       |          |              |       |    |
| 31            | "            | 2,880  | 8.0        | —      |                                                                                                                       |          |              |       |    |
| 32            | "            | 2,859  | —          | 1.0    |                                                                                                                       |          |              |       |    |
| 33            | "            | 2,934  | 9.2        | —      |                                                                                                                       |          |              |       |    |
| 34            | "            | 2,932  | 6.0        | —      |                                                                                                                       |          |              |       |    |
| 35            | "            | 2,893  | 9.0        | —      |                                                                                                                       |          |              |       |    |
| 36            | "            | 2,873  | 8.0        | —      |                                                                                                                       |          |              |       |    |
| 37            | "            | 2,941  | 8.0        | —      |                                                                                                                       |          |              |       |    |
| 38            | "            | 2,898  | 4.0        | —      |                                                                                                                       |          |              |       |    |
| 39            | "            | 3,144  | —          | 4.0    |                                                                                                                       |          |              |       |    |
| 40            | "            | 2,904  | 9.0        | —      |                                                                                                                       |          |              |       |    |
| 41            | "            | 2,932  | 11.4       | —      |                                                                                                                       |          |              |       |    |
| 42            | "            | 3,037  | 6.4        | —      |                                                                                                                       |          |              |       |    |
| 43            | "            | 2,892  | 6.2        | —      |                                                                                                                       |          |              |       |    |
| 44            | "            | 2,881  | 5.2        | —      |                                                                                                                       |          |              |       |    |
| 45            | "            | 2,823  | —          | 5.0    |                                                                                                                       |          |              |       |    |



# FIRST SERIES.—70-POUNDER WHITWORTH.

## EXPERIMENTS TO DETERMINE RANGE AND ACCURACY.

### SOLID SHOT.

SHOEBURYNESS.

*Ordinance.*  
 Weight, 77 cwt. 1 qr.  
 Length, 2 ft. 10·5 in.  
 Diameter of circle { circums<sup>d</sup>. 5·53 in.  
                               ins<sup>d</sup>. 5·03 in.  
 Length of bore, 9 feet.  
 Spiral, 1 in 18·0831 calibres.

*Projectile and Ammunition.*  
 Weight, 70 lbs. 1½ oz.  
 Diameter { major, 5·46 in.  
               minor, 4·98 in.  
 Length, 15·04 in.  
 Length of cartridge, 16·5 in.  
 Diameter of cartridge, 4·85 in.  
 Brand of powder, A4.  
 Charge, 10 lbs.  
 Wad, lubricator, Boxer's, filled with oil.

The gun was vented in the ordinary manner.

| No. of Round. | Elevation.   | Range. | Recoil. | 1st Graze. |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|---------------|--------------|--------|---------|------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        |         | Right.     | Left.  |                                                                                                                                                         |          |              |       |    |       |    |
|               | °            | Yards. | Ft. in. | Yards.     | Yards. | June 28, 1864.                                                                                                                                          |          |              |       |    |       |    |
| 1             | 0            | 440    | —       | —          | 10·0   |                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "            | 480    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 492    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "            | 488    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "            | 491    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 6             | "            | 450    | —       | —          | 10·8   |                                                                                                                                                         |          |              |       |    |       |    |
| 7             | "            | 480    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 8             | "            | 474    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 9             | "            | 492    | —       | —          | 10·2   |                                                                                                                                                         |          |              |       |    |       |    |
| 10            | "            | 484    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 11            | "            | 468    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "            | 476    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 13            | "            | 487    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 14            | "            | 486    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 15            | "            | 490    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 16            | "            | 483    | —       | —          | 10·2   |                                                                                                                                                         |          |              |       |    |       |    |
| 17            | "            | 482    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 18            | "            | 500    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 19            | "            | 490    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 20            | "            | 485    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 21            | "            | 486    | —       | —          | 10·8   | The gun was 12 yards 1 foot left of line.                                                                                                               |          |              |       |    |       |    |
| 22            | "            | 485    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 23            | "            | 480    | —       | —          | 10·4   | Weather :—Thick haze on water, 10 a.m.                                                                                                                  |          |              |       |    |       |    |
| 24            | "            | 479    | —       | —          | 10·8   | Very thick haze and slight rain, 3 p.m.                                                                                                                 |          |              |       |    |       |    |
| 25            | "            | 456    | —       | —          | 11·0   |                                                                                                                                                         |          |              |       |    |       |    |
| 26            | "            | 499    | —       | —          | 11·2   | Wind :—Direction N.W. by W. ; force, 4; 10 a.m.                                                                                                         |          |              |       |    |       |    |
| 27            | "            | 484    | —       | —          | 10·8   | " S.W. by W. ; " 3; 3 p.m.                                                                                                                              |          |              |       |    |       |    |
| 28            | "            | 496    | —       | —          | 11·0   |                                                                                                                                                         |          |              |       |    |       |    |
| 29            | "            | 489    | —       | —          | 10·6   | Thermometer :—61 dry, 58 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 30            | "            | 480    | —       | —          | 10·8   | 64 " 61 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 31            | "            | 494    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 32            | "            | 493    | —       | —          | 10·4   | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·18</td><td>60</td></tr><tr><td>30·00</td><td>62</td></tr></table> 10 a.m. | Reading. | Temperature. | 30·18 | 60 | 30·00 | 62 |
| Reading.      | Temperature. |        |         |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·18         | 60           |        |         |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·00         | 62           |        |         |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 33            | "            | 494    | —       | —          | 10·6   | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 34            | "            | 491    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 35            | "            | 497    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 36            | "            | 478    | —       | —          | 10·8   | The breech screw was started $\frac{1}{8}$ th of an inch by the                                                                                         |          |              |       |    |       |    |
| 37            | "            | 502    | —       | —          | 10·4   | firing.                                                                                                                                                 |          |              |       |    |       |    |
| 38            | "            | 496    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 39            | "            | 473    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 40            | "            | 489    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 41            | "            | 500    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 42            | "            | 496    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 43            | "            | 480    | —       | —          | 10·8   |                                                                                                                                                         |          |              |       |    |       |    |
| 44            | "            | 492    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 45            | "            | 487    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 46            | "            | 490    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 47            | "            | 489    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 48            | "            | 492    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 49            | "            | 490    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 50            | "            | 492    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 51            | "            | 481    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 52            | "            | 498    | —       | —          | 10·8   |                                                                                                                                                         |          |              |       |    |       |    |
| 53            | "            | 493    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 54            | "            | 494    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 55            | "            | 485    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 56            | "            | 496    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |
| 57            | "            | 467    | —       | —          | 10·6   |                                                                                                                                                         |          |              |       |    |       |    |
| 58            | "            | 494    | —       | —          | 10·4   |                                                                                                                                                         |          |              |       |    |       |    |

## RANGE AND ACCURACY.—SOLID SHOT—continued.

| No. of Round.  | Elevation.   | Range.       | Recoil.   | 1st Graze. |            | Remarks.                                                                                                                                                                                |          |              |  |       |    |         |       |    |        |
|----------------|--------------|--------------|-----------|------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|--|-------|----|---------|-------|----|--------|
|                |              |              |           | Right.     | Left.      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| June 13, 1864. |              |              |           |            |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1              | 3            | Yards. 1,753 | Ft. in. — | Yards. —   | Yards. 5.4 |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 2              | "            | 1,732        | —         | —          | 6.0        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3              | "            | 1,717        | —         | —          | 8.0        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 4              | "            | 1,739        | —         | —          | 5.2        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 5              | "            | 1,760        | —         | —          | 5.2        | The gun was 12 yards 1 foot left of line.                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 6              | "            | 1,741        | —         | —          | 6.2        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 7              | "            | 1,748        | —         | —          | 5.8        | The breech screw having become loosened by the firing, it was screwed up.                                                                                                               |          |              |  |       |    |         |       |    |        |
| 8              | "            | 1,752        | —         | —          | 6.6        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 9              | "            | 1,720        | —         | —          | 8.4        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 10             | "            | 1,767        | —         | —          | 7.0        | Weather :—Hazy and raining, 10 a.m.                                                                                                                                                     |          |              |  |       |    |         |       |    |        |
| 11             | "            | 1,748        | —         | —          | 5.2        | Clear, 3 p.m.                                                                                                                                                                           |          |              |  |       |    |         |       |    |        |
| 12             | "            | 1,745        | —         | —          | 6.8        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 13             | "            | 1,765        | —         | —          | 6.0        | Wind :—Direction, S.E. by S. ; force, 2 ; 10 a.m.                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 14             | "            | 1,757        | —         | —          | 8.6        | " " " 2 ; 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 15             | "            | 1,777        | —         | —          | 7.2        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 16             | "            | 1,751        | —         | —          | 6.0        | Thermometer :—60 dry, 57 wet, 10 a.m.                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 17             | "            | 1,756        | —         | —          | 6.4        | 61 " 59 " 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 18             | "            | 1,770        | —         | —          | 3.8        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>29.75</td><td>62</td><td>10 a.m.</td></tr><tr><td>29.70</td><td>62</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 29.75 | 62 | 10 a.m. | 29.70 | 62 | 3 p.m. |
| Reading.       | Temperature. |              |           |            |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29.75          | 62           | 10 a.m.      |           |            |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29.70          | 62           | 3 p.m.       |           |            |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19             | "            | 1,790        | —         | —          | 8.8        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20             | "            | 1,747        | —         | —          | 6.0        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 21             | "            | 1,820        | —         | —          | 5.2        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 22             | "            | 1,770        | —         | —          | 5.6        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 23             | "            | 1,766        | —         | —          | 5.4        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| June 14, 1864. |              |              |           |            |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1              | 3            | 1,750        | —         | —          | 7.2        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 2              | "            | 1,743        | —         | —          | 6.8        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3              | "            | 1,718        | —         | —          | 7.0        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 4              | "            | 1,728        | —         | —          | 8.2        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 5              | "            | 1,719        | —         | —          | 6.4        | 5th shot not seen and therefore not recorded.                                                                                                                                           |          |              |  |       |    |         |       |    |        |
| 6              | "            | 1,707        | —         | —          | 7.2        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 7              | "            | 1,712        | —         | —          | 6.2        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 8              | "            | 1,702        | —         | —          | 7.2        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 9              | "            | 1,720        | —         | —          | 8.0        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 10             | "            | 1,741        | —         | —          | 9.2        | The gun was 12 yards 1 foot left of line.                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 11             | "            | 1,750        | —         | —          | 7.4        | Weather :—Clear, 10 a.m.                                                                                                                                                                |          |              |  |       |    |         |       |    |        |
| 12             | "            | 1,700        | —         | —          | 8.0        | " 3 p.m.                                                                                                                                                                                |          |              |  |       |    |         |       |    |        |
| 13             | "            | 1,708        | —         | —          | 8.2        | Wind :—Direction, S.E. by S. ; force, 3 ; 10 a.m.                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 14             | "            | 1,732        | —         | —          | 8.4        | " S.W. by W. ; " 4 ; 3 p.m.                                                                                                                                                             |          |              |  |       |    |         |       |    |        |
| 15             | "            | 1,708        | —         | —          | 10.0       |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 16             | "            | 1,762        | —         | —          | 8.0        | Thermometer :—64 dry, 59 wet, 10 a.m.                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 17             | "            | 1,755        | —         | —          | 9.2        | 68 " 63 " 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 18             | "            | 1,342        | —         | —          | 9.0*       | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>29.70</td><td>63</td><td>10 a.m.</td></tr><tr><td>29.60</td><td>65</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 29.70 | 63 | 10 a.m. | 29.60 | 65 | 3 p.m. |
| Reading.       | Temperature. |              |           |            |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29.70          | 63           | 10 a.m.      |           |            |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29.60          | 65           | 3 p.m.       |           |            |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19             | "            | 1,750        | —         | —          | 10.0       |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20             | "            | 1,768        | —         | —          | 8.4        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 21             | "            | 1,793        | —         | —          | 7.8        | *Struck out by order of the Committee.                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 22             | "            | 1,750        | —         | —          | 10.0       |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 23             | "            | 1,736        | —         | —          | 7.4        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 24             | "            | 1,760        | —         | —          | 10.0       |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 25             | "            | 1,794        | —         | —          | 8.8        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 26             | "            | 1,725        | —         | —          | 7.6        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 27             | "            | 1,738        | —         | —          | 8.2        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 28             | "            | 1,750        | —         | —          | 10.0       |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29             | "            | 1,775        | —         | —          | 10.4       |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 30             | "            | 1,764        | —         | —          | 8.4        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 31             | "            | 1,768        | —         | —          | 9.2        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| June 15, 1864. |              |              |           |            |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1              | 3            | 1,778        | —         | —          | 6.6        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 2              | "            | 1,734        | —         | —          | 6.2        | The gun was 12 yards 1 foot left of line.                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 3              | "            | 1,760        | —         | —          | 6.8        | Weather :—Cloudy, 10 a.m.                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 4              | "            | 1,744        | —         | —          | 6.4        | Rain, 3 p.m.                                                                                                                                                                            |          |              |  |       |    |         |       |    |        |
| 5              | "            | 1,761        | —         | —          | 7.4        | Wind :—Direction N.W. by N. ; force, 6 ; 10 a.m.                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 6              | "            | 1,755        | —         | —          | 6.6        | " S.W. by W. ; " 3 ; 3 p.m.                                                                                                                                                             |          |              |  |       |    |         |       |    |        |
| 7              | "            | 1,762        | —         | —          | 6.0        | Thermometer :—61 dry, 56 wet, 10 a.m.                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 8              | "            | 1,754        | —         | —          | 6.4        | 60 " 56 " 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 9              | "            | 1,749        | —         | —          | 4.6        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 10             | "            | 1,732        | —         | —          | 5.8        | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>29.70</td><td>62</td><td>10 a.m.</td></tr><tr><td>29.70</td><td>62</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 29.70 | 62 | 10 a.m. | 29.70 | 62 | 3 p.m. |
| Reading.       | Temperature. |              |           |            |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29.70          | 62           | 10 a.m.      |           |            |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29.70          | 62           | 3 p.m.       |           |            |            |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 11             | "            | 1,768        | —         | —          | 4.8        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 12             | "            | 1,773        | —         | —          | 5.6        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |



## RANGE AND ACCURACY.—SOLID SHOT—continued.

| No. of Round.  | Elevation.   | Range.  | Recoil.           | 1st Graze. |        | Remarks.                                                                                                                                                                                                                                                                                                                                                                              |          |              |  |       |    |         |       |    |        |
|----------------|--------------|---------|-------------------|------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|--|-------|----|---------|-------|----|--------|
|                |              |         |                   | Right.     | Left.  |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
|                | °            | Yards.  | Ft. in.           | Yards.     | Yards. |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 1              | 6            | 3,010   | —                 | 6.4        | —      | June 15, 1864.<br><br>The gun was 12 yards 1 foot left of line.                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 2              | "            | 2,998   | —                 | 6.2        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 3              | "            | 2,990   | —                 | 6.6        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 4              | "            | 2,966   | —                 | —          | 1.2    |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 5              | "            | 3,047   | —                 | 2.8        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 6              | "            | 3,048   | —                 | 0.8        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| June 16, 1864. |              |         |                   |            |        |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 1              | 6            | 3,013   | 5 6 $\frac{1}{4}$ | 8.0        | —      | The gun was 12 yards 1 foot left of line.                                                                                                                                                                                                                                                                                                                                             |          |              |  |       |    |         |       |    |        |
| 2              | "            | 3,011   | 4 11              | 9.8        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 3              | "            | 3,032   | 4 7 $\frac{1}{2}$ | 6.4        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 4              | "            | 2,991   | 4 6               | 6.8        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 5              | "            | 3,030   | 4 3 $\frac{1}{4}$ | 10.0       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 6              | "            | 2,990   | 4 3 $\frac{1}{4}$ | 5.2        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 7              | "            | 3,040   | 4 1               | 6.6        | —      | Weather :—Hazy, 10 a.m.<br>Clearing up, 3 p.m.<br><br>Wind :—Direction S. by W.; force, 5; 10 a.m.<br>" " " 4; 3 p.m.<br><br>Thermometer :—56 dry, 54 wet, 10 a.m.<br>58 " 56 " 3 p.m.<br><br>Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>29.75</td><td>58</td><td>10 a.m.</td></tr><tr><td>29.80</td><td>60</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 29.75 | 58 | 10 a.m. | 29.80 | 60 | 3 p.m. |
| Reading.       | Temperature. |         |                   |            |        |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 29.75          | 58           | 10 a.m. |                   |            |        |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 29.80          | 60           | 3 p.m.  |                   |            |        |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 8              | "            | 3,019   | 4 0               | 7.0        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 9              | "            | 3,009   | 4 0               | 5.4        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 10             | "            | 3,038   | 4 0               | 7.2        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 11             | "            | 3,015   | —                 | 9.6        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 12             | "            | 2,998   | —                 | 7.0        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 13             | "            | 3,049   | —                 | 9.0        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 14             | "            | 3,035   | —                 | 8.8        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 15             | "            | 3,037   | —                 | 8.8        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 16             | "            | 3,057   | —                 | 5.2        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 17             | "            | 3,043   | —                 | 10.2       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 18             | "            | 3,047   | —                 | 7.4        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 19             | "            | 3,059   | —                 | 10.0       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 20             | "            | 3,066   | —                 | 6.8        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 21             | "            | 3,049   | —                 | 6.0        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 22             | "            | 3,094   | —                 | 11.2       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 23             | "            | 3,054   | —                 | 8.2        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 24             | "            | 3,043   | —                 | 10.6       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 25             | "            | 3,018   | —                 | 6.6        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 26             | "            | 3,055   | —                 | 6.8        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 27             | "            | 3,053   | —                 | 6.6        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 28             | "            | 3,050   | —                 | 6.2        | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| June 27, 1864. |              |         |                   |            |        |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 1              | 6            | 2,946   | —                 | 15.0       | —      | The gun was 12 yards 1 foot left of line.                                                                                                                                                                                                                                                                                                                                             |          |              |  |       |    |         |       |    |        |
| 2              | "            | 2,968   | —                 | 12.6       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 3              | "            | 2,940   | —                 | 15.0       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 4              | "            | 2,908   | —                 | 15.4       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 5              | "            | 2,954   | —                 | 14.6       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 6              | "            | 2,960   | —                 | 14.0       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 7              | "            | 2,914   | —                 | 13.2       | —      | Weather :—Cloudy, 10 a.m.<br>" 3 p.m.<br><br>Wind :—Direction N.N.W.; force, 4; 10 a.m.<br>" " " 3; 3 p.m.<br><br>Thermometer :—61 dry, 55 wet, 10 a.m.<br>61 " 57 " 3 p.m.<br><br>Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>30.10</td><td>59</td><td>10 a.m.</td></tr><tr><td>30.15</td><td>59</td><td>3 p.m.</td></tr></table>            | Reading. | Temperature. |  | 30.10 | 59 | 10 a.m. | 30.15 | 59 | 3 p.m. |
| Reading.       | Temperature. |         |                   |            |        |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 30.10          | 59           | 10 a.m. |                   |            |        |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 30.15          | 59           | 3 p.m.  |                   |            |        |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 8              | "            | 2,964   | —                 | 17.4       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 9              | "            | 2,934   | —                 | 12.0       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 10             | "            | 2,992   | —                 | 14.4       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 11             | "            | 2,944   | —                 | 12.0       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 12             | "            | 2,969   | —                 | 13.6       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 13             | "            | 2,962   | —                 | 14.2       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 14             | "            | 3,000   | —                 | 14.0       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 15             | "            | 2,988   | —                 | 14.4       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 16             | "            | 2,970   | —                 | 12.2       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 17             | "            | 2,961   | —                 | 11.6       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 18             | "            | 3,016   | —                 | 12.8       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 19             | "            | 2,986   | —                 | 13.2       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 20             | "            | 2,988   | —                 | 14.2       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 21             | "            | 3,000   | —                 | 15.4       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 22             | "            | 2,964   | —                 | 14.4       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 23             | "            | 2,997   | —                 | 13.0       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 24             | "            | 2,991   | —                 | 12.2       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 25             | "            | 3,000   | —                 | 11.2       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 26             | "            | 2,988   | —                 | 14.8       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 27             | "            | 2,962   | —                 | 12.6       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 28             | "            | 2,948   | —                 | 13.4       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 29             | "            | 2,990   | —                 | 12.0       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 30             | "            | 3,017   | —                 | 13.4       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 31             | "            | 2,968   | —                 | 13.0       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 32             | "            | 2,980   | —                 | 14.2       | —      |                                                                                                                                                                                                                                                                                                                                                                                       |          |              |  |       |    |         |       |    |        |

RANGE AND ACCURACY.—SOLID SHOT—continued.

| No. of Round.  | Elevation.   | Range. | Recoil. | 1st Graze. |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|----------------|--------------|--------|---------|------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|                |              |        |         | Right.     | Left.  |                                                                                                                                                         |          |              |       |    |       |    |
|                | °            | Yards. | Ft. in. | Yards.     | Yards. | July 11, 1864.                                                                                                                                          |          |              |       |    |       |    |
| 1              | 9            | 3,998  | —       | 24·6       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 2              | "            | 4,000  | —       | 26·0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3              | "            | 4,041  | —       | 25·4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 4              | "            | 4,015  | —       | 22·8       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 5              | "            | 4,007  | —       | 22·6       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 6              | "            | 3,994  | —       | 23·4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 7              | "            | 4,013  | —       | 24·4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 8              | "            | 4,088  | —       | 23·8       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 9              | "            | 4,023  | —       | 24·4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 10             | "            | 4,042  | —       | 24·2       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 11             | "            | 4,032  | —       | 28·4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 12             | "            | 4,037  | —       | 28·6       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 13             | "            | 4,047  | —       | 23·2       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 14             | "            | 3,969  | —       | 23·6       | —      | The gun was 12 yards 1 foot left of line.                                                                                                               |          |              |       |    |       |    |
| 15             | "            | 4,030  | —       | 23·8       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 16             | "            | 4,060  | —       | 26·4       | —      | Weather :—Very slight haze, 10 a.m.                                                                                                                     |          |              |       |    |       |    |
| 17             | "            | 4,034  | —       | 27·6       | —      | " " 3 p.m.                                                                                                                                              |          |              |       |    |       |    |
| 18             | "            | 4,002  | —       | 26·8       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 19             | "            | 4,023  | —       | 26·6       | —      | Wind :—Direction, E. by S. ; force, 4 ; 10 a.m.                                                                                                         |          |              |       |    |       |    |
| 20             | "            | 4,034  | —       | 26·0       | —      | " " ; " 5 ; 3 p.m.                                                                                                                                      |          |              |       |    |       |    |
| 21             | "            | 3,987  | —       | 26·6       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 22             | "            | 4,035  | —       | 27·6       | —      | Thermometer :—68 dry, 67 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 23             | "            | 4,036  | —       | 28·6       | —      | 71 " 70 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 24             | "            | 4,023  | —       | 27·6       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 25             | "            | 4,050  | —       | 24·8       | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·22</td><td>67</td></tr><tr><td>30·15</td><td>66</td></tr></table> 10 a.m. | Reading. | Temperature. | 30·22 | 67 | 30·15 | 66 |
| Reading.       | Temperature. |        |         |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·22          | 67           |        |         |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·15          | 66           |        |         |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 26             | "            | 4,044  | —       | 26·0       | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 27             | "            | 4,019  | —       | 26·6       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 28             | "            | 4,045  | —       | 26·8       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 29             | "            | 3,969  | —       | 26·6       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 30             | "            | 4,048  | —       | 22·8       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 31             | "            | 4,006  | —       | 23·2       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 32             | "            | 4,023  | —       | 21·6       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 33             | "            | 4,013  | —       | 23·8       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 34             | "            | 4,041  | —       | 24·2       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 35             | "            | 4,067  | —       | 23·8       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 36             | "            | 4,659  | —       | 21·6       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 37             | "            | 4,082  | —       | 22·6       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 38             | "            | 4,050  | —       | 22·0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 39             | "            | 4,011  | —       | 22·2       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 40             | "            | 4,042  | —       | 17·4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| July 12, 1864. |              |        |         |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 1              | 15           | 5,996  | —       | 47·0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 2              | "            | 5,954  | —       | 39·2       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3              | "            | 5,959  | —       | 46·8       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 4              | "            | 5,983  | —       | 40·2       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 5              | "            | 5,996  | —       | 43·0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 6              | "            | 6,005  | —       | 39·4       | —      | The gun was 10 feet left of the line.                                                                                                                   |          |              |       |    |       |    |
| 7              | "            | 5,997  | —       | 43·4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 8              | "            | 6,002  | —       | 46·2       | —      | Weather :—Hazy on water, 10 a.m.                                                                                                                        |          |              |       |    |       |    |
| 9              | "            | 6,090  | —       | 46·6       | —      | Clear, 3 p.m.                                                                                                                                           |          |              |       |    |       |    |
| 10             | "            | 5,883  | —       | 44·0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 11             | "            | 5,981  | —       | 47·6       | —      | Wind :—Direction, N.E. ; force, 2 ; 10 a.m.                                                                                                             |          |              |       |    |       |    |
| 12             | "            | 5,981  | —       | 54·2       | —      | " E. by S. " 4 ; 3 p.m.                                                                                                                                 |          |              |       |    |       |    |
| 13             | "            | 6,093  | —       | 42·0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 14             | "            | 6,002  | —       | 36·4       | —      | Thermometer :—60 dry, 59 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 15             | "            | 6,005  | —       | 43·2       | —      | 64 " 61 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 16             | "            | 6,004  | —       | 42·0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 17             | "            | 6,095  | —       | 36·0       | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·15</td><td>62</td></tr><tr><td>30·23</td><td>65</td></tr></table> 10 a.m. | Reading. | Temperature. | 30·15 | 62 | 30·23 | 65 |
| Reading.       | Temperature. |        |         |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·15          | 62           |        |         |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·23          | 65           |        |         |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 18             | "            | 6,098  | —       | 39·2       | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 19             | "            | 6,095  | —       | 45·2       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 20             | "            | 5,996  | —       | 37·0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 21             | "            | 6,106  | —       | 30·4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 22             | "            | 6,079  | —       | 36·2       | —      |                                                                                                                                                         |          |              |       |    |       |    |

RANGE AND ACCURACY.—SOLID SHOT—*continued.*

| No. of Round.  | Elevation.   | Range. | Recoil. | 1st Graze. |        | Remarks.                                                                                                              |          |              |       |    |
|----------------|--------------|--------|---------|------------|--------|-----------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|
|                |              |        |         | Right.     | Left.  |                                                                                                                       |          |              |       |    |
|                | °            | Yards. | Ft. in. | Yards.     | Yards. |                                                                                                                       |          |              |       |    |
| 1              | 17           | 6,482  | —       | 80·4       | —      | July 13, 1864.                                                                                                        |          |              |       |    |
| 2              | "            | 6,500  | —       | 61·6       | —      |                                                                                                                       |          |              |       |    |
| 3              | "            | 6,476  | —       | 67·0       | —      |                                                                                                                       |          |              |       |    |
| 4              | "            | 6,422  | —       | 75·4       | —      |                                                                                                                       |          |              |       |    |
| 5              | "            | 6,414  | —       | 64·0       | —      | The gun was 10 feet to left of the line.                                                                              |          |              |       |    |
| 6              | "            | 6,492  | —       | 61·6       | —      |                                                                                                                       |          |              |       |    |
| 7              | "            | 6,447  | —       | 53·0       | —      | Weather :—Clear, 10 a.m.                                                                                              |          |              |       |    |
| 8              | "            | 6,444  | —       | 52·4       | —      | " 3 p.m.                                                                                                              |          |              |       |    |
| 9              | "            | 6,432  | —       | 51·6       | —      |                                                                                                                       |          |              |       |    |
| 10             | "            | 6,492  | —       | 48·0       | —      | Wind :—Direction, N.E. by E. ; force, 4 ; 10 a.m.                                                                     |          |              |       |    |
| 11             | "            | 6,424  | —       | 45·4       | —      | " E. by S. " 5 ; 3 p.m.                                                                                               |          |              |       |    |
| 12             | "            | 6,487  | —       | 75·2       | —      |                                                                                                                       |          |              |       |    |
| 13             | "            | 6,465  | —       | 46·4       | —      | Thermometer :—62 dry, 60 wet, 10 a.m.                                                                                 |          |              |       |    |
| 14             | "            | 6,473  | —       | 62·6       | —      | 65 " 62 " 3 p.m.                                                                                                      |          |              |       |    |
| 15             | "            | 6,450  | —       | 46·0       | —      |                                                                                                                       |          |              |       |    |
| 16             | "            | 6,458  | —       | 61·4       | —      |                                                                                                                       |          |              |       |    |
| 17             | "            | 6,500  | —       | 64·4       | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·05</td><td>65</td></tr></table> 10 a.m. | Reading. | Temperature. | 30·05 | 65 |
| Reading.       | Temperature. |        |         |            |        |                                                                                                                       |          |              |       |    |
| 30·05          | 65           |        |         |            |        |                                                                                                                       |          |              |       |    |
| 18             | "            | 6,482  | —       | 43·2       | —      | 30·10 60 3 p.m.                                                                                                       |          |              |       |    |
| 19             | "            | 6,479  | —       | 42·4       | —      |                                                                                                                       |          |              |       |    |
| 20             | "            | 6,411  | —       | 67·8       | —      |                                                                                                                       |          |              |       |    |
| 21             | "            | 6,400  | —       | 52·0       | —      |                                                                                                                       |          |              |       |    |
| 22             | "            | 6,450  | —       | 54·6       | —      |                                                                                                                       |          |              |       |    |
| July 13, 1864. |              |        |         |            |        |                                                                                                                       |          |              |       |    |
| 1              | 19           | 7,000  | —       | 63·4       | —      |                                                                                                                       |          |              |       |    |
| 2              | "            | 7,018  | —       | 54·6       | —      |                                                                                                                       |          |              |       |    |
| 3              | "            | 6,993  | —       | 53·0       | —      |                                                                                                                       |          |              |       |    |
| 4              | "            | 6,996  | —       | 46·4       | —      |                                                                                                                       |          |              |       |    |
| 5              | "            | 6,940  | —       | 52·8       | —      | The gun was 10 feet to left of line.                                                                                  |          |              |       |    |
| 6              | "            | 6,980  | —       | 54·2       | —      |                                                                                                                       |          |              |       |    |
| 7              | "            | 7,000  | —       | 56·0       | —      |                                                                                                                       |          |              |       |    |
| 8              | "            | 6,998  | —       | 58·4       | —      |                                                                                                                       |          |              |       |    |
| 9              | "            | 7,022  | —       | 54·0       | —      |                                                                                                                       |          |              |       |    |
| 10             | "            | 6,990  | —       | 53·4       | —      |                                                                                                                       |          |              |       |    |
| July 14, 1864. |              |        |         |            |        |                                                                                                                       |          |              |       |    |
| 1              | 19           | 7,292  | —       | 70·8       | —      |                                                                                                                       |          |              |       |    |
| 2              | "            | 7,306  | —       | 67·6       | —      |                                                                                                                       |          |              |       |    |
| 3              | "            | 7,350  | —       | 68·8       | —      |                                                                                                                       |          |              |       |    |
| 4              | "            | 7,248  | —       | 60·8       | —      | The gun was 10 feet left of line.                                                                                     |          |              |       |    |
| 5              | "            | 7,300  | —       | 68·4       | —      |                                                                                                                       |          |              |       |    |
| 6              | "            | 7,250  | —       | 62·8       | —      | Weather :—Clear, 10 a.m.                                                                                              |          |              |       |    |
| 7              | "            | 7,280  | —       | 78·0       | —      | " 3 p.m.                                                                                                              |          |              |       |    |
| 8              | "            | 7,315  | —       | 67·6       | —      |                                                                                                                       |          |              |       |    |
| 9              | "            | 7,360  | —       | 57·4       | —      | Wind :—Direction, E. by S. ; force, 5 ; 10 a.m.                                                                       |          |              |       |    |
| 10             | "            | 7,275  | —       | 59·6       | —      | " S.E. by S. " 2 ; 3 p.m.                                                                                             |          |              |       |    |
| 11             | "            | 7,250  | —       | 62·0       | —      |                                                                                                                       |          |              |       |    |
| 12             | "            | 7,215  | —       | 60·8       | —      |                                                                                                                       |          |              |       |    |
| July 14, 1864. |              |        |         |            |        |                                                                                                                       |          |              |       |    |
| 1              | 21           | 7,800  | —       | 72·0       | —      |                                                                                                                       |          |              |       |    |
| 2              | "            | 7,750  | —       | 84·0       | —      |                                                                                                                       |          |              |       |    |
| 3              | "            | 7,700  | —       | 71·6       | —      |                                                                                                                       |          |              |       |    |
| 4              | "            | 7,718  | —       | 72·8       | —      |                                                                                                                       |          |              |       |    |
| 5              | "            | 7,824  | —       | 68·8       | —      |                                                                                                                       |          |              |       |    |
| 6              | "            | 7,760  | —       | 79·4       | —      |                                                                                                                       |          |              |       |    |
| 7              | "            | 7,784  | —       | 70·8       | —      |                                                                                                                       |          |              |       |    |
| 8              | "            | 7,712  | —       | 86·6       | —      | The gun was 10 feet left of line.                                                                                     |          |              |       |    |
| 9              | "            | 7,743  | —       | 82·6       | —      |                                                                                                                       |          |              |       |    |
| 10             | "            | 7,820  | —       | 79·6       | —      | Thermometer :—60 dry, 57 wet, 10 a.m.                                                                                 |          |              |       |    |
| 11             | "            | 7,900  | —       | 76·6       | —      | 67 " 63 " 3 p.m.                                                                                                      |          |              |       |    |
| 12             | "            | 7,800  | —       | 84·0       | —      |                                                                                                                       |          |              |       |    |
| 13             | "            | 7,840  | —       | 76·6       | —      |                                                                                                                       |          |              |       |    |
| 14             | "            | 7,809  | —       | 86·8       | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·20</td><td>63</td></tr></table> 10 a.m. | Reading. | Temperature. | 30·20 | 63 |
| Reading.       | Temperature. |        |         |            |        |                                                                                                                       |          |              |       |    |
| 30·20          | 63           |        |         |            |        |                                                                                                                       |          |              |       |    |
| 15             | "            | 7,850  | —       | 74·6       | —      | 30·22 62 3 p.m.                                                                                                       |          |              |       |    |
| 16             | "            | 7,720  | —       | 84·8       | —      |                                                                                                                       |          |              |       |    |
| 17             | "            | 7,760  | —       | 82·6       | —      |                                                                                                                       |          |              |       |    |
| 18             | "            | 7,815  | —       | 83·8       | —      |                                                                                                                       |          |              |       |    |
| 19             | "            | 7,850  | —       | 70·6       | —      |                                                                                                                       |          |              |       |    |
| 20             | "            | 7,862  | —       | 76·4       | —      |                                                                                                                       |          |              |       |    |
| 21             | "            | 7,890  | —       | 73·8       | —      |                                                                                                                       |          |              |       |    |
| 22             | "            | 7,846  | —       | 81·4       | —      |                                                                                                                       |          |              |       |    |

RANGE AND ACCURACY.—SOLID SHOT—*continued.*

| No. of Round. | Eleva-<br>tion. | Range. | Recoil. | 1st Graze. |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|---------------|-----------------|--------|---------|------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |                 |        |         | Right.     | Left.  |                                                                                                                                                         |          |              |       |    |       |    |
|               | °               | Yards. | Ft. in. | Yards.     | Yards. | September 22, 1864.                                                                                                                                     |          |              |       |    |       |    |
| 1             | 5               | 2,318  | —       | 4.0        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "               | 2,240  | —       | 1.0        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "               | 2,300  | —       | 7.2        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "               | 2,312  | —       | 2.0        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "               | 2,314  | —       | 3.0        | —      | Gun fired from the rear vent.                                                                                                                           |          |              |       |    |       |    |
| 6             | "               | 2,314  | —       | 3.2        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 7             | "               | 2,330  | —       | 5.0        | —      | The gun was 10 feet left of line.                                                                                                                       |          |              |       |    |       |    |
| 8             | "               | 2,301  | —       | 7.2        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 9             | "               | 2,290  | —       | 8.4        | —      | Weather :—Clear.                                                                                                                                        |          |              |       |    |       |    |
| 10            | "               | 2,301  | —       | 9.4        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 11            | "               | 2,260  | —       | 8.4        | —      | Wind :—Direction, S.W. by W. ; force, 3 ; 10 a.m.                                                                                                       |          |              |       |    |       |    |
| 12            | "               | 2,340  | —       | 7.4        | —      | " W.S.W. " 4 ; 3 p.m.                                                                                                                                   |          |              |       |    |       |    |
| 13            | "               | 2,312  | —       | 6.0        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 14            | "               | 2,240  | —       | 0.4        | —      | Thermometer :—61 dry, 58 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 15            | "               | 2,301  | —       | 6.0        | —      | 67 " 59 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 16            | "               | 2,312  | —       | 8.0        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 17            | "               | 2,320  | —       | 6.4        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 18            | "               | 2,290  | —       | 5.0        | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.85</td><td>61</td></tr><tr><td>29.85</td><td>64</td></tr></table> 10 a.m. | Reading. | Temperature. | 29.85 | 61 | 29.85 | 64 |
| Reading.      | Temperature.    |        |         |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29.85         | 61              |        |         |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29.85         | 64              |        |         |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 19            | "               | 2,280  | —       | 7.2        | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 20            | "               | 2,340  | —       | 3.0        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 1             | 8               | 3,430  | —       | 20.4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "               | 3,420  | —       | 16.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "               | 3,456  | —       | 15.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "               | 3,440  | —       | 20.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "               | 3,410  | —       | 22.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 6             | "               | 3,424  | —       | 20.4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 7             | "               | 3,510  | —       | 19.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 8             | "               | 3,410  | —       | 15.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 9             | "               | 3,446  | —       | 18.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 10            | "               | 3,500  | —       | 18.4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 11            | "               | 3,490  | —       | 21.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "               | 3,480  | —       | 20.4       | —      | The gun was 10 feet left of line.                                                                                                                       |          |              |       |    |       |    |
| 13            | "               | 3,390  | —       | 9.0        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 14            | "               | 3,450  | —       | 17.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 15            | "               | 3,400  | —       | 7.2        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 16            | "               | 3,445  | —       | 6.0        | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 17            | "               | 3,413  | —       | 20.2       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 18            | "               | 3,440  | —       | 19.4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 19            | "               | 3,500  | —       | 14.4       | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 20            | "               | 3,500  | —       | 12.0       | —      |                                                                                                                                                         |          |              |       |    |       |    |

## RANGE AND ACCURACY—continued.

## COMMON SHELL.

SHOEBURYNESS.

*Projectile and Ammunition.*

Nature, common shell.

Weight,  $49\frac{1}{2}$  lbs.

Diameter, major, 5.46 inches.

Diameter, minor, 4.98 inches.

Length; 15 inches.

Bursting charge, 2 lbs. 8 oz.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | In Line.   | Right. | Left.  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
|               | °            | Yards. |            | Yards. | Yards. | <i>September 7, 1864.</i><br><br>Gun fired from the rear vent.<br><br>The gun was 10 feet left of line.<br><br>Weather :—Very hazy, 10 a.m.<br>Hazy, 3 p.m.<br><br>Wind :—Direction, N.W. by W. ; force, 3 ; 10 a.m.<br>" " " " 2 ; 3 p.m.<br><br>Thermometer :—67 dry, 66 wet, 10 am.<br>" " 69 " 67 " 3 p.m.<br><br>Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.05</td><td>64</td></tr><tr><td>30.05</td><td>66</td></tr></table> 10 a.m.<br>3 p.m. | Reading. | Temperature. | 30.05 | 64 | 30.05 | 66 |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 30.05         | 64           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 30.05         | 66           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 1             | 4            | 2,252  | —          | 6.6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "            | 2,285  | —          | —      | 0.6    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 2,302  | —          | 12.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "            | 2,301  | —          | 5.4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "            | 2,157  | —          | 10.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 6             | "            | 2,177  | —          | 7.6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 7             | "            | 2,167  | —          | 0.4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 8             | "            | 2,209  | —          | 7.6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 9             | "            | 2,170  | —          | 3.4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 10            | "            | 2,169  | —          | 11.2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 11            | "            | 2,214  | —          | 12.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "            | 2,139  | —          | 4.0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 13            | "            | 2,248  | —          | 1.4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 14            | "            | 2,228  | —          | 12.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 15            | "            | 2,197  | —          | 5.2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 16            | "            | 2,167  | —          | 4.0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 17            | "            | 2,248  | —          | 12.4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 18            | "            | 2,182  | —          | 5.2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 19            | "            | 2,216  | —          | 1.0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 20            | "            | 2,213  | —          | 2.4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 21            | "            | 2,254  | —          | 2.6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 22            | "            | 2,244  | —          | 1.6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 23            | "            | 2,236  | —          | 12.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 24            | "            | 2,251  | —          | 7.0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 25            | "            | 2,202  | —          | 12.2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 26            | "            | 2,220  | —          | 13.2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 27            | "            | 2,243  | —          | 4.0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 28            | "            | 2,238  | —          | 14.2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 29            | "            | 2,242  | —          | 1.4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 30            | "            | 2,267  | —          | 7.2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 31            | "            | 2,234  | —          | 2.4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 32            | "            | 2,293  | —          | 8.6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 33            | "            | 2,181  | —          | 4.4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 34            | "            | 2,158  | —          | 4.6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 35            | "            | 2,210  | —          | 6.0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 36            | "            | 2,159  | —          | 12.0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 37            | "            | 2,183  | —          | 6.2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 38            | "            | 2,246  | —          | 4.2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 39            | "            | 2,191  | —          | 9.0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 40            | "            | 2,182  | —          | 8.4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 41            | "            | 2,207  | —          | 7.0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |



RANGE AND ACCURACY.—COMMON SHELL—*continued.*

| No. of Round. | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | In Line.   | Right. | Left.  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
|               | °            | Yards. |            | Yards. | Yards. | <div>September 9, 1864.</div> <div>The gun was 10 feet left of line.</div> <div>Weather :—Clear, 10 a.m.<br/>Slight haze, 3 p.m.</div> <div>Wind :—Direction, W. ; force, 5 ; 10 a.m.<br/>" " " 7 ; 3 p.m.</div> <div>Thermometer :—68 dry, 65 wet, 10 a.m.<br/>" 69 " 66 " 3 p.m.</div> <div>Barometer :—<table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·05</td><td>66</td></tr><tr><td>29·95</td><td>67</td></tr></table> 10 a.m.<br/>3 p.m.</div> | Reading. | Temperature. | 30·05 | 66 | 29·95 | 67 |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 30·05         | 66           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 29·95         | 67           |        |            |        |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 1             | 7            | 3,561  | —          | 11·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 2             | "            | 3,460  | —          | 4·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 3             | "            | 3,476  | —          | 11·2   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 4             | "            | 3,460  | —          | 3·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 5             | "            | 3,498  | Yes.       | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 6             | "            | 3,570  | —          | 0·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 7             | "            | 3,490  | Yes.       | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 8             | "            | 3,478  | —          | 7·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 9             | "            | 3,547  | —          | 12·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 10            | "            | 3,472  | —          | 5·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 11            | "            | 3,515  | —          | —      | 4·0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 12            | "            | 3,378  | —          | 12·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 13            | "            | 3,411  | —          | 7·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 14            | "            | 3,465  | —          | 7·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 15            | "            | 3,451  | —          | 2·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 16            | "            | 3,509  | —          | 6·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 17            | "            | 3,545  | —          | 7·6    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 18            | "            | 3,485  | —          | 10·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 19            | "            | 3,562  | —          | 12·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 20            | "            | 3,470  | —          | 4·2    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 21            | "            | 3,491  | —          | 6·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 22            | "            | 3,487  | —          | 2·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 23            | "            | 3,504  | —          | —      | 6·4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 24            | "            | 3,511  | —          | 1·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 25            | "            | 3,447  | —          | 8·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 26            | "            | 3,552  | —          | 4·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 27            | "            | 3,497  | —          | —      | 6·0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 28            | "            | 3,458  | —          | —      | 2·0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 29            | "            | 3,511  | —          | —      | 5·6    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 30            | "            | 3,522  | —          | —      | 5·0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 31            | "            | 3,480  | —          | 12·4   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 32            | "            | 3,491  | —          | 0·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 33            | "            | 3,531  | —          | 0·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 34            | "            | 3,485  | —          | 2·8    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 35            | "            | 3,579  | —          | 5·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 36            | "            | 3,447  | —          | 6·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 37            | "            | 3,495  | —          | 7·4    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 38            | "            | 3,386  | —          | 6·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 39            | "            | 3,509  | —          | —      | 5·0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 40            | "            | 3,504  | —          | 14·0   | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 41            | "            | 3,513  | —          | —      | 0·2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 42            | "            | 3,494  | —          | —      | 5·8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 43            | "            | 3,449  | —          | 5·0    | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |
| 44            | "            | 3,539  | —          | —      | 3·0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |              |       |    |       |    |



RANGE AND ACCURACY—*continued.*

## BOXER'S SHRAPNEL SHELL.

SHOEBURYNESS.

*Projectile and Ammunition.*

Nature, shrapnel shell (Boxer's).  
 Weight, 67 lbs. 5 oz.  
 Diameter, major, 5'46 inches.

Diameter, minor, 4'98 inches.  
 Length, 15'46.  
 Bursting charge, 1 or 3 oz.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                       |          |              |       |            |       |           |
|---------------|--------------|--------|------------|--------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|------------|-------|-----------|
|               |              |        | In Line.   | Right. | Left.  |                                                                                                                                                                |          |              |       |            |       |           |
|               | °            | Yards. |            | Yards. | Yards. | June 30, 1864.                                                                                                                                                 |          |              |       |            |       |           |
| 1             | 2            | 1,398  | —          | —      | 6.0    |                                                                                                                                                                |          |              |       |            |       |           |
| 2             | "            | 1,367  | —          | —      | 6.4    |                                                                                                                                                                |          |              |       |            |       |           |
| 3             | "            | 1,357  | —          | —      | 7.4    |                                                                                                                                                                |          |              |       |            |       |           |
| 4             | "            | 1,386  | —          | —      | 6.6    |                                                                                                                                                                |          |              |       |            |       |           |
| 5             | "            | 1,352  | —          | —      | 6.2    |                                                                                                                                                                |          |              |       |            |       |           |
| 6             | "            | 1,318  | —          | —      | 7.8    |                                                                                                                                                                |          |              |       |            |       |           |
| 7             | "            | 1,359  | —          | —      | 7.0    |                                                                                                                                                                |          |              |       |            |       |           |
| 8             | "            | 1,344  | —          | —      | 6.6    |                                                                                                                                                                |          |              |       |            |       |           |
| 9             | "            | 1,337  | —          | —      | 6.8    |                                                                                                                                                                |          |              |       |            |       |           |
| 10            | "            | 1,317  | —          | —      | 5.4    |                                                                                                                                                                |          |              |       |            |       |           |
| 11            | "            | 1,379  | —          | —      | 7.0    |                                                                                                                                                                |          |              |       |            |       |           |
| 12            | "            | 1,355  | —          | —      | 7.2    |                                                                                                                                                                |          |              |       |            |       |           |
| 13            | "            | 1,366  | —          | —      | 6.4    |                                                                                                                                                                |          |              |       |            |       |           |
| 14            | "            | 1,407  | —          | —      | 6.8    |                                                                                                                                                                |          |              |       |            |       |           |
| 15            | "            | 1,353  | —          | —      | 5.6    |                                                                                                                                                                |          |              |       |            |       |           |
| 16            | "            | 1,390  | —          | —      | 6.2    |                                                                                                                                                                |          |              |       |            |       |           |
| 17            | "            | 1,381  | —          | —      | 6.6    | The gun was 12 yards 1 foot left of line.                                                                                                                      |          |              |       |            |       |           |
| 18            | "            | 1,353  | —          | —      | 7.0    |                                                                                                                                                                |          |              |       |            |       |           |
| 19            | "            | 1,366  | —          | —      | 5.6    | Weather :—Clear, 10 a.m.                                                                                                                                       |          |              |       |            |       |           |
| 20            | "            | 1,350  | —          | —      | 6.4    | Slight haze, 3 p.m.                                                                                                                                            |          |              |       |            |       |           |
| 21            | "            | 1,357  | —          | —      | 6.0    |                                                                                                                                                                |          |              |       |            |       |           |
| 22            | "            | 1,380  | —          | —      | 6.2    | Wind :—Direction, N.W. by N. ; force, 5 ; 10 a.m.                                                                                                              |          |              |       |            |       |           |
| 23            | "            | 1,362  | —          | —      | 7.2    | " " " 4 ; 3 p.m.                                                                                                                                               |          |              |       |            |       |           |
| 24            | "            | 1,366  | —          | —      | 7.2    |                                                                                                                                                                |          |              |       |            |       |           |
| 25            | "            | 1,375  | —          | —      | 6.8    | Thermometer :—63 dry, 60 wet, 10 a.m.                                                                                                                          |          |              |       |            |       |           |
| 26            | "            | 1,389  | —          | —      | 8.2    | 68 " 62 " 3 p.m.                                                                                                                                               |          |              |       |            |       |           |
| 27            | "            | 1,399  | —          | —      | 6.2    |                                                                                                                                                                |          |              |       |            |       |           |
| 28            | "            | 1,400  | —          | —      | 6.2    |                                                                                                                                                                |          |              |       |            |       |           |
| 29            | "            | 1,380  | —          | —      | 6.4    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29.95</td><td>61 10 a.m.</td></tr><tr><td>29.95</td><td>64 3 p.m.</td></tr></table> | Reading. | Temperature. | 29.95 | 61 10 a.m. | 29.95 | 64 3 p.m. |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                                                                |          |              |       |            |       |           |
| 29.95         | 61 10 a.m.   |        |            |        |        |                                                                                                                                                                |          |              |       |            |       |           |
| 29.95         | 64 3 p.m.    |        |            |        |        |                                                                                                                                                                |          |              |       |            |       |           |
| 30            | "            | 1,367  | —          | —      | 7.0    |                                                                                                                                                                |          |              |       |            |       |           |
| 31            | "            | 1,363  | —          | —      | 6.8    |                                                                                                                                                                |          |              |       |            |       |           |
| 32            | "            | 1,381  | —          | —      | 8.2    |                                                                                                                                                                |          |              |       |            |       |           |
| 33            | "            | 1,366  | —          | —      | 6.2    |                                                                                                                                                                |          |              |       |            |       |           |
| 34            | "            | 1,403  | —          | —      | 6.8    |                                                                                                                                                                |          |              |       |            |       |           |
| 35            | "            | 1,394  | —          | —      | 6.4    |                                                                                                                                                                |          |              |       |            |       |           |
| 36            | "            | 1,386  | —          | —      | 6.6    |                                                                                                                                                                |          |              |       |            |       |           |
| 37            | "            | 1,358  | —          | —      | 7.2    |                                                                                                                                                                |          |              |       |            |       |           |
| 38            | "            | 1,388  | —          | —      | 6.6    |                                                                                                                                                                |          |              |       |            |       |           |
| 39            | "            | 1,371  | —          | —      | 6.8    |                                                                                                                                                                |          |              |       |            |       |           |
| 40            | "            | 1,363  | —          | —      | 7.0    |                                                                                                                                                                |          |              |       |            |       |           |
| 41            | "            | 1,399  | —          | —      | 6.4    |                                                                                                                                                                |          |              |       |            |       |           |
| 42            | "            | 1,356  | —          | —      | 7.8    |                                                                                                                                                                |          |              |       |            |       |           |
| 43            | "            | 1,342  | —          | —      | 7.2    |                                                                                                                                                                |          |              |       |            |       |           |
| 44            | "            | 1,358  | —          | —      | 6.4    |                                                                                                                                                                |          |              |       |            |       |           |

RANGE AND ACCURACY.—BOXER'S SHRAPNEL SHELL—*continued.*

| No. of Round. | Elevation.   | Range.  | 1st Graze. |        |        | Remarks.                                                                                                                                                                                |          |              |  |       |    |         |       |    |        |
|---------------|--------------|---------|------------|--------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|--|-------|----|---------|-------|----|--------|
|               |              |         | In Line.   | Right. | Left.  |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
|               | °            | Yards.  |            | Yards. | Yards. |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1             | 5            | 2,632   | —          | 6·0    | —      | July 1, 1864.                                                                                                                                                                           |          |              |  |       |    |         |       |    |        |
| 2             | "            | 2,618   | —          | 5·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3             | "            | 2,604   | —          | 6·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 4             | "            | 2,594   | —          | 5·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 5             | "            | 2,590   | —          | 2·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 6             | "            | 2,604   | —          | 6·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 7             | "            | 2,592   | —          | 4·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 8             | "            | 2,598   | —          | 0·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 9             | "            | 2,592   | —          | 2·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 10            | "            | 2,622   | —          | 3·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 11            | "            | 2,660   | —          | 3·4    | —      | The gun was 12 yards 1 foot left of line.                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 12            | "            | 2,624   | —          | 5·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 13            | "            | 2,650   | —          | 5·4    | —      | Weather :—Clear, 10 a.m.<br>Slight haze, 3 p.m.                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 14            | "            | 2,625   | —          | 4·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 15            | "            | 2,615   | —          | 2·0    | —      | Wind :—Direction, N.N.W.; force, 4; 10 a.m.<br>" N.W. " 4; 3 p.m.                                                                                                                       |          |              |  |       |    |         |       |    |        |
| 16            | "            | 2,630   | —          | 4·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 17            | "            | 2,618   | —          | 4·2    | —      | Thermometer :—60 dry, 56 wet, 10 a.m.<br>67 " 60 " 3 p.m.                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 18            | "            | 2,664   | —          | 4·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19            | "            | 2,648   | —          | 3·8    | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>29·95</td><td>60</td><td>10 a.m.</td></tr><tr><td>30·00</td><td>63</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 29·95 | 60 | 10 a.m. | 30·00 | 63 | 3 p.m. |
| Reading.      | Temperature. |         |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29·95         | 60           | 10 a.m. |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 30·00         | 63           | 3 p.m.  |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20            | "            | 2,594   | —          | 7·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 21            | "            | 2,608   | —          | 6·2    | —      | The shell jammed about 4 feet down the bore, but was eventually forced down by means of an iron rammer; this caused a delay of 26 minutes.                                              |          |              |  |       |    |         |       |    |        |
| 22            | "            | 2,644   | —          | 2·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 23            | "            | 2,633   | —          | 4·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 24            | "            | 2,656   | —          | 5·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 25            | "            | 2,600   | Yes.       | —      | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 26            | "            | 2,642   | —          | 5·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 27            | "            | 2,653   | —          | 3·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 28            | "            | 2,634   | —          | 1·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29            | "            | 2,622   | —          | 3·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 30            | "            | 2,652   | —          | 4·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 31            | "            | 2,611   | —          | 0·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 32            | "            | 2,642   | —          | 0·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 33            | "            | 2,662   | —          | 6·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 34            | "            | 2,614   | —          | 6·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 35            | "            | 2,591   | —          | 3·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 36            | "            | 2,606   | —          | 3·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 37            | "            | 2,610   | —          | 3·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 38            | "            | 2,650   | —          | 3·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 39            | "            | 2,642   | —          | 3·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 40            | "            | 2,608   | —          | 2·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 41            | "            | 2,692   | —          | 0·6    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 42            | "            | 2,642   | —          | 1·0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 43            | "            | 2,616   | —          | 6·2    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 44            | "            | 2,650   | —          | 3·4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |

## RANGE AND ACCURACY.—BOXER'S SHRAPNEL SHELL—continued.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | In Line.   | Right. | Left.  |                                                                                                                                                         |          |              |       |    |       |    |
|               | °            | Yards. |            | Yards. | Yards. | September 13, 1864.                                                                                                                                     |          |              |       |    |       |    |
| 1             | 8            | 3,417  | —          | 12·8   | —      | The gun was fired from the rear vent.                                                                                                                   |          |              |       |    |       |    |
| 2             | "            | 3,500  | —          | 11·4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 3,490  | —          | 7·2    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "            | 3,465  | —          | 9·6    | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 5             | "            | 3,494  | —          | 9·2    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 6             | "            | 3,487  | —          | 9·4    | —      | The gun was 10 feet left of line.                                                                                                                       |          |              |       |    |       |    |
| 7             | "            | 3,457  | —          | 11·0   | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 8             | "            | —      | —          | —      | —      | Shell broke up in the gun.                                                                                                                              |          |              |       |    |       |    |
| 9             | "            | 3,409  | —          | 12·0   | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 10            | "            | 3,467  | —          | 3·0    | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 11            | "            | 3,472  | —          | 15·0   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "            | 3,438  | —          | 12·0   | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 13            | "            | 3,451  | —          | 14·8   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 14            | "            | 3,426  | —          | 8·0    | —      | Weather :—Clear.                                                                                                                                        |          |              |       |    |       |    |
| 15            | "            | 3,470  | —          | 15·4   | —      | Wind :—Direction, W.S.W. ; force, 3 ; 10 a.m.                                                                                                           |          |              |       |    |       |    |
| 16            | "            | 3,500  | —          | 8·0    | —      | " S.W. by S. " 5 ; 3 p.m.                                                                                                                               |          |              |       |    |       |    |
| 17            | "            | 3,468  | —          | 11·2   | —      | Thermometer :—60 dry, 59 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 18            | "            | 3,507  | —          | 7·0    | —      | 62 " 60 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 19            | "            | 3,448  | —          | 11·4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 20            | "            | 3,486  | —          | 10·4   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30·05</td><td>58</td></tr><tr><td>29·95</td><td>61</td></tr></table> 10 a.m. | Reading. | Temperature. | 30·05 | 58 | 29·95 | 61 |
| Reading.      | Temperature. |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30·05         | 58           |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·95         | 61           |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 21            | "            | 3,556  | —          | 10·0   | —      | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 22            | "            | 3,505  | —          | 9·0    | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 23            | "            | 3,483  | —          | 9·6    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 24            | "            | 3,504  | —          | 10·4   | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 25            | "            | 3,472  | —          | 8·0    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 26            | "            | 3,528  | —          | 7·8    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 27            | "            | 3,472  | —          | 6·0    | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 28            | "            | 3,585  | —          | 5·4    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 29            | "            | 3,426  | —          | 8·4    | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 30            | "            | 3,488  | —          | 8·6    | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 31            | "            | 3,507  | —          | 10·4   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 32            | "            | 3,493  | —          | 6·6    | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 33            | "            | 3,459  | —          | 10·8   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 34            | "            | 3,535  | —          | 2·8    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 35            | "            | 3,517  | —          | 5·0    | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 36            | "            | 3,489  | —          | 13·6   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 37            | "            | 3,483  | —          | 6·0    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 38            | "            | 3,510  | —          | 3·4    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 39            | "            | 3,498  | —          | 1·4    | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 40            | "            | 3,480  | —          | 12·8   | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 41            | "            | 3,430  | —          | 5·2    | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 42            | "            | 3,445  | —          | 10·2   | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 43            | "            | 3,444  | —          | 8·0    | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |
| 44            | "            | 3,506  | —          | 6·0    | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 45            | "            | 3,416  | —          | 6·4    | —      | Broke up.                                                                                                                                               |          |              |       |    |       |    |

The firing was stopped on Sept. 13th, after two rounds had been fired, owing to the vent being choked up. Eighty-seven rounds had been fired from the vent.



# FIRST SERIES.—70-POUNDER MUZZLE-LOADING ARMSTRONG.

## EXPERIMENTS FOR DETERMINING RANGE AND ACCURACY. SHOT (HOLLOW HEADED).

SHOEBURYNESS.

### Ordnance.

Weight, 75 cwt.  
Length, 10 ft. 3.25 in.  
Diameter of bore, 6.4 in.  
Length of bore, 9 ft.  
Grooves, No. 3.  
Windage, 0.06 in.  
Spiral, 1 turn in 256 in.,  
40 calibres, nearly.

### Projectile and Ammunition.

Weight, 70.6 lbs.  
Diameter, 6.34 in.  
Length, 12.81 in.  
No. of buttons, 15, in 3 rows.  
Projection of buttons, .11 in.  
Breadth of buttons at top,  
.45 in.

Breadth of buttons at bottom,  
.59 in.  
Length of cartridge, 12 in.  
Diameter, 5 in.  
Brand of powder, A4.  
Charge, 10 lbs.  
Wad, Boxer's lubricator, filled  
with oil.

| No. of Round. | Elevation.   | Range. | Recoil. | 1st Graze. |        |        | Remarks.                                                                                                                                                                                                                                                                               |          |              |       |    |       |    |
|---------------|--------------|--------|---------|------------|--------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        |         | In Line.   | Right. | Left.  |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
|               | °            | Yards. | Ft. In. |            | Yards. | Yards. |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 1             | 0            | 480    | —       | —          | —      | 7.4    | June 28, 1864.                                                                                                                                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "            | 464    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 3             | "            | 439    | —       | —          | —      | 5.8    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 4             | "            | 493    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 5             | "            | 451    | —       | —          | —      | 6.4    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 6             | "            | 482    | —       | —          | —      | 6.4    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 7             | "            | 466    | —       | —          | —      | 5.8    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 8             | "            | 470    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 9             | "            | 480    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 10            | "            | 477    | —       | —          | —      | 6.2    | The shot stuck a little in loading, and required five blows to drive it home.                                                                                                                                                                                                          |          |              |       |    |       |    |
| 11            | "            | 489    | —       | —          | —      | 5.8    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 12            | "            | 458    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 13            | "            | 492    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 14            | "            | 491    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 15            | "            | 467    | —       | —          | —      | 5.6    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 16            | "            | 487    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 17            | "            | 477    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 18            | "            | 470    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 19            | "            | 463    | —       | —          | —      | 6.2    | The gun was 6 yds. 2 ft. left of line.<br>Weather :—Thick haze on water, 10 a.m.<br>Very thick haze and slight rain, 3 p.m.<br>Wind :—Direction, N.W. by W.; force, 4; 10 a.m.<br>Direction, S.W. by W.; force, 3; 3 p.m.<br>Thermometer :—61 dry, 58 wet, 10 a.m.<br>64 „ 61 „ 3 p.m. |          |              |       |    |       |    |
| 20            | "            | 491    | —       | —          | —      | 6.4    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 21            | "            | 488    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 22            | "            | 480    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 23            | "            | 487    | —       | —          | —      | 5.8    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 24            | "            | 485    | —       | —          | —      | 5.4    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 25            | "            | 458    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 26            | "            | 479    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 27            | "            | 494    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 28            | "            | 481    | —       | —          | —      | 6.0    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.18</td><td>60</td></tr><tr><td>30.00</td><td>62</td></tr></table> 10 a.m.<br>3 p.m.                                                                                                                      | Reading. | Temperature. | 30.18 | 60 | 30.00 | 62 |
| Reading.      | Temperature. |        |         |            |        |        |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 30.18         | 60           |        |         |            |        |        |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 30.00         | 62           |        |         |            |        |        |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 29            | "            | 465    | —       | —          | —      | 6.4    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 30            | "            | 482    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 31            | "            | 495    | —       | —          | —      | 5.8    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 32            | "            | 462    | —       | —          | —      | 6.6    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 33            | "            | 480    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 34            | "            | 483    | —       | —          | —      | 6.6    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 35            | "            | 458    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 36            | "            | 484    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 37            | "            | 482    | —       | —          | —      | 5.6    | Shot stuck, and required several blows to ram home; sponge wetted to facilitate the loading.<br>40th Round.—Twelve blows required to ram home.<br>Water required again, and the sponge was occasionally wetted during the rest of the practice.                                        |          |              |       |    |       |    |
| 38            | "            | 461    | —       | —          | —      | 6.4    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 39            | "            | 453    | —       | —          | —      | 5.6    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 40            | "            | 482    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 41            | "            | 485    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 42            | "            | 483    | —       | —          | —      | 6.4    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 43            | "            | 481    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 44            | "            | 496    | —       | —          | —      | 6.4    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 45            | "            | 497    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 46            | "            | 496    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 47            | "            | 491    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 48            | "            | 487    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 49            | "            | 468    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 50            | "            | 450    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 51            | "            | 457    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 52            | "            | 460    | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 53            | "            | 485    | —       | —          | —      | 5.8    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 54            | "            | 481    | —       | —          | —      | 6.4    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 55            | "            | 466    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 56            | "            | 482    | —       | —          | —      | 6.6    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 57            | "            | 455    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |
| 58            | "            | 464    | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                        |          |              |       |    |       |    |



## RANGE AND ACCURACY.—SHOT—continued.

| No. of Round. | Elevation. | Range. | Recoil. | 1st Graze. |        |        | Remarks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------|------------|--------|---------|------------|--------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |            |        |         | In Line.   | Right. | Left.  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|               | °          | Yards. | Ft. In. |            | Yards. | Yards. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 1             | 3          | 1,677  | —       | —          | —      | 2.0    | <p><i>June 13, 1864.</i></p> <p>The gun was 6 yds. 2 ft. left of line.</p> <p>Weather :—Hazy and raining, 10 a.m.<br/>Clear, 3 p.m.</p> <p>Wind :—Direction, S.E. by E.; force, 2; 10 a.m.<br/>" " " 2; 3 p.m.</p> <p>Thermometer :—60 dry, 57 wet, 10 a.m.<br/>61 " 59 " 3 p.m.</p> <p>Barometer :—<sup>Reading.</sup> 29.75 <sup>Temperature.</sup> 62 10 a.m.<br/>29.70 62 3 p.m.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 2             | "          | 1,659  | —       | —          | —      | 3.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 3             | "          | 1,669  | —       | —          | —      | 3.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 4             | "          | 1,643  | —       | —          | —      | 1.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 5             | "          | 1,660  | —       | —          | —      | 2.0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 6             | "          | 1,678  | —       | —          | —      | 2.6    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 7             | "          | 1,683  | —       | —          | —      | 0.6    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 8             | "          | 1,657  | —       | —          | —      | 4.0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 9             | "          | 1,669  | —       | —          | —      | 1.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 10            | "          | 1,678  | —       | —          | —      | 4.2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 11            | "          | 1,654  | —       | —          | —      | 2.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 12            | "          | 1,665  | —       | —          | —      | 2.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 13            | "          | 1,703  | —       | —          | —      | 2.2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 14            | "          | 1,705  | —       | —          | —      | 2.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 15            | "          | 1,668  | —       | —          | —      | 3.2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 16            | "          | 1,642  | —       | —          | —      | 3.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 17            | "          | 1,682  | —       | —          | —      | 2.6    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 18            | "          | 1,700  | —       | —          | —      | 2.2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 19            | "          | 1,689  | —       | —          | —      | 4.2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 20            | "          | 1,660  | —       | —          | —      | 3.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 21            | "          | 1,668  | —       | —          | —      | 4.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 22            | "          | 1,692  | —       | —          | —      | 1.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 23            | "          | 1,725  | —       | —          | —      | 0.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|               |            |        |         |            |        |        | <i>June 14, 1864.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 1             | 3          | 1,689  | —       | —          | —      | 4.0    | <p>Omitted to correspond with Whitworth ;<br/>"not seen."</p> <p>The gun was 6 yds. 2 ft. left of line.</p> <p>Weather :—Clear.</p> <p>Wind :—Direction, S.E. by S.; force, 3; 10 a.m.<br/>" S.W. by W.; " 4; 3 p.m.</p> <p>Thermometer :—64 dry, 59 wet, 10 a.m.<br/>68 " 63 " 3 p.m.</p> <p>Barometer :—<sup>Reading.</sup> 29.70 <sup>Temperature.</sup> 63 10 a.m.<br/>29.60 65 3 p.m.</p> <p>30th Round.—Great difficulty experienced in<br/>ramming home the shot ; the gun very foul.</p> <p><i>June 15, 1864.</i></p> <p>The gun was 6 yds. 2 ft. left of line.</p> <p>Weather :—Cloudy, 10 a.m.<br/>Rain, 3 p.m.</p> <p>Wind :—Direction, N.W. by N.; force, 6; 10 a.m.<br/>" S.W. by W.; " 3; 3 p.m.</p> <p>Thermometer :—61 dry, 56 wet, 10 a.m.<br/>60 " 56 " 3 p.m.</p> <p>Barometer :—<sup>Reading.</sup> 29.70 <sup>Temperature.</sup> 62 10 a.m.<br/>29.70 62 3 p.m.</p> |
| 2             | "          | 1,668  | —       | —          | —      | 4.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 3             | "          | 1,650  | —       | —          | —      | 5.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 4             | "          | 1,686  | —       | —          | —      | 3.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 5             | "          | —      | —       | —          | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 6             | "          | 1,670  | —       | —          | —      | 3.2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 7             | "          | 1,671  | —       | —          | —      | 4.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 8             | "          | 1,672  | —       | —          | —      | 4.6    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 9             | "          | 1,659  | —       | —          | —      | 3.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 10            | "          | 1,666  | —       | —          | —      | 2.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 11            | "          | 1,684  | —       | —          | —      | 1.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 12            | "          | 1,657  | —       | —          | —      | 2.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 13            | "          | 1,693  | —       | —          | —      | 2.0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 14            | "          | 1,707  | —       | —          | —      | 2.0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 15            | "          | 1,748  | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 16            | "          | 1,711  | —       | —          | —      | 5.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 17            | "          | 1,747  | —       | —          | —      | 4.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 18            | "          | 1,694  | —       | —          | —      | 5.0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 19            | "          | 1,751  | —       | —          | —      | 4.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 20            | "          | 1,657  | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 21            | "          | 1,696  | —       | —          | —      | 8.2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 22            | "          | 1,735  | —       | —          | —      | 5.2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 23            | "          | 1,692  | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 24            | "          | 1,740  | —       | —          | —      | 5.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 25            | "          | 1,754  | —       | —          | —      | 5.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 26            | "          | 1,708  | —       | —          | —      | 5.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 27            | "          | 1,742  | —       | —          | —      | 6.2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 28            | "          | 1,766  | —       | —          | —      | 5.2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 29            | "          | 1,769  | —       | —          | —      | 5.0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 30            | "          | 1,739  | —       | —          | —      | 6.0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 31            | "          | 1,739  | —       | —          | —      | 4.2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 32            | "          | 1,708  | —       | —          | —      | 4.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|               |            |        |         |            |        |        | <i>June 15, 1864.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 1             | 3          | 1,688  | —       | —          | —      | 2.0    | <p>The gun was 6 yds. 2 ft. left of line.</p> <p>Weather :—Cloudy, 10 a.m.<br/>Rain, 3 p.m.</p> <p>Wind :—Direction, N.W. by N.; force, 6; 10 a.m.<br/>" S.W. by W.; " 3; 3 p.m.</p> <p>Thermometer :—61 dry, 56 wet, 10 a.m.<br/>60 " 56 " 3 p.m.</p> <p>Barometer :—<sup>Reading.</sup> 29.70 <sup>Temperature.</sup> 62 10 a.m.<br/>29.70 62 3 p.m.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 2             | "          | 1,710  | —       | —          | —      | 1.8    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 3             | "          | 1,714  | —       | —          | —      | 2.0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 4             | "          | 1,742  | —       | —          | —      | 1.6    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 5             | "          | 1,744  | —       | Yes.       | —      | —      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 6             | "          | 1,738  | —       | —          | —      | 0.6    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 7             | "          | 1,666  | —       | —          | —      | 1.2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 8             | "          | 1,714  | —       | —          | —      | 0.2    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 9             | "          | 1,667  | —       | —          | —      | 1.4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 10            | "          | 1,672  | —       | —          | —      | 2.0    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 11            | "          | 1,690  | —       | —          | —      | 1.6    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |



## RANGE AND ACCURACY.—SHOT—continued.

| No. of Round. | Elevation.   | Range.  | Recoil.           | 1st Graze. |        |        | Remarks.                                                                                                                                                                                |          |              |  |       |    |         |       |    |        |
|---------------|--------------|---------|-------------------|------------|--------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|--|-------|----|---------|-------|----|--------|
|               |              |         |                   | In Line.   | Right. | Left.  |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
|               | °            | Yards.  | Ft. In.           |            | Yards. | Yards. |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 1             | 6            | 2,800   | —                 | —          | 12.0   | —      | June 15, 1864.                                                                                                                                                                          |          |              |  |       |    |         |       |    |        |
| 2             | "            | 2,792   | —                 | —          | 12.0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3             | "            | 2,816   | —                 | —          | 10.0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 4             | "            | 2,830   | —                 | —          | 7.2    | —      | The gun was 6 yds. 2 ft. left of line.                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 5             | "            | 2,845   | —                 | —          | 6.4    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 6             | "            | 2,818   | —                 | —          | 5.0    | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
|               |              |         |                   |            |        |        | June 16, 1864.                                                                                                                                                                          |          |              |  |       |    |         |       |    |        |
| 1             | 6            | 2,768   | 4 10              | —          | 12.4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 2             | "            | 2,762   | 4 10              | —          | 10.8   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3             | "            | 2,764   | 4 7               | —          | 10.0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 4             | "            | 2,786   | 4 5 $\frac{1}{4}$ | —          | 12.4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 5             | "            | 2,834   | 4 7               | —          | 13.4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 6             | "            | 2,789   | 4 7 $\frac{1}{2}$ | —          | 12.8   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 7             | "            | 2,775   | 4 1               | —          | 13.0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 8             | "            | 2,806   | 4 2               | —          | 13.8   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 9             | "            | 2,772   | 4 1 $\frac{1}{2}$ | —          | 10.0   | —      | The gun was 6 yds. 2 ft. left of line.                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 10            | "            | 2,812   | 4 0               | —          | 12.4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 11            | "            | 2,800   | —                 | —          | 11.2   | —      | Weather :—Hazy, 10 a.m.                                                                                                                                                                 |          |              |  |       |    |         |       |    |        |
| 12            | "            | 2,871   | —                 | —          | 9.6    | —      | Clearing up, 3 p.m.                                                                                                                                                                     |          |              |  |       |    |         |       |    |        |
| 13            | "            | 2,799   | —                 | —          | 12.2   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 14            | "            | 2,789   | —                 | —          | 11.6   | —      | Wind :—Direction, S. by W.; force, 5 ; 10 a.m.                                                                                                                                          |          |              |  |       |    |         |       |    |        |
| 15            | "            | 2,805   | —                 | —          | 12.4   | —      | " " " 4 ; 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 16            | "            | 2,816   | —                 | —          | 10.4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 17            | "            | 2,844   | —                 | —          | 15.6   | —      | Thermometer :—56 dry, 54 wet, 10 a.m.                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 18            | "            | 2,779   | —                 | —          | 13.2   | —      | 58 " 56 " 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 19            | "            | 2,805   | —                 | —          | 14.4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 20            | "            | 2,850   | —                 | —          | 14.6   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 21            | "            | 2,812   | —                 | —          | 13.6   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>29.75</td><td>58</td><td>10 a.m.</td></tr><tr><td>29.80</td><td>60</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 29.75 | 58 | 10 a.m. | 29.80 | 60 | 3 p.m. |
| Reading.      | Temperature. |         |                   |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29.75         | 58           | 10 a.m. |                   |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29.80         | 60           | 3 p.m.  |                   |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 22            | "            | 2,840   | —                 | —          | 14.4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 23            | "            | 2,804   | —                 | —          | 11.8   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 24            | "            | 2,814   | —                 | —          | 15.4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 25            | "            | 2,808   | —                 | —          | 11.6   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 26            | "            | 2,809   | —                 | —          | 12.4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 27            | "            | 2,801   | —                 | —          | 12.0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 28            | "            | 2,802   | —                 | —          | 13.6   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
|               |              |         |                   |            |        |        | June 27, 1864.                                                                                                                                                                          |          |              |  |       |    |         |       |    |        |
| 1             | 6            | 2,754   | —                 | —          | 16.2   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 2             | "            | 2,713   | —                 | —          | 13.4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 3             | "            | 2,648   | —                 | —          | 15.0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 4             | "            | 2,712   | —                 | —          | 14.2   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 5             | "            | 2,760   | —                 | —          | —      | 45     |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 6             | "            | 2,715   | —                 | —          | 14.8   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 7             | "            | 2,761   | —                 | —          | 15.6   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 8             | "            | 2,780   | —                 | —          | 19.0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 9             | "            | 2,719   | —                 | —          | 17.4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 10            | "            | 2,786   | —                 | —          | 14.2   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 11            | "            | 2,732   | —                 | —          | 13.2   | —      | The gun was 6 yds. 2 ft. left of line.                                                                                                                                                  |          |              |  |       |    |         |       |    |        |
| 12            | "            | 2,750   | —                 | —          | 18.0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 13            | "            | 2,753   | —                 | —          | 19.4   | —      | Weather :—Cloudy, 10 a.m.                                                                                                                                                               |          |              |  |       |    |         |       |    |        |
| 14            | "            | 2,649   | —                 | —          | 11.4   | —      | " 3 p.m.                                                                                                                                                                                |          |              |  |       |    |         |       |    |        |
| 15            | "            | 2,745   | —                 | —          | 17.0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 16            | "            | 2,760   | —                 | —          | 15.2   | —      | Wind :—Direction, N.N.W.; force, 4 ; 10 a.m.                                                                                                                                            |          |              |  |       |    |         |       |    |        |
| 17            | "            | 2,745   | —                 | —          | 18.2   | —      | " " " 3 ; 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 18            | "            | 2,760   | —                 | —          | 15.6   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 19            | "            | 2,746   | —                 | —          | 14.2   | —      | Thermometer :—61 dry, 55 wet, 10 a.m.                                                                                                                                                   |          |              |  |       |    |         |       |    |        |
| 20            | "            | 2,749   | —                 | —          | 17.6   | —      | 61 " 57 " 3 p.m.                                                                                                                                                                        |          |              |  |       |    |         |       |    |        |
| 21            | "            | 2,730   | —                 | —          | 18.2   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 22            | "            | 2,748   | —                 | —          | 15.2   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 23            | "            | 2,752   | —                 | —          | 19.0   | —      | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td><td></td></tr><tr><td>30.10</td><td>59</td><td>10 a.m.</td></tr><tr><td>30.15</td><td>59</td><td>3 p.m.</td></tr></table> | Reading. | Temperature. |  | 30.10 | 59 | 10 a.m. | 30.15 | 59 | 3 p.m. |
| Reading.      | Temperature. |         |                   |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 30.10         | 59           | 10 a.m. |                   |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 30.15         | 59           | 3 p.m.  |                   |            |        |        |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 24            | "            | 2,739   | —                 | —          | 15.2   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 25            | "            | 2,801   | —                 | —          | 18.4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 26            | "            | 2,812   | —                 | —          | 14.2   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 27            | "            | 2,752   | —                 | —          | 19.2   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 28            | "            | 2,791   | —                 | —          | 18.8   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 29            | "            | 2,792   | —                 | —          | 17.0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 30            | "            | 2,766   | —                 | —          | 15.4   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 31            | "            | 2,743   | —                 | —          | 17.2   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |
| 32            | "            | 2,760   | —                 | —          | 14.0   | —      |                                                                                                                                                                                         |          |              |  |       |    |         |       |    |        |

RANGE AND ACCURACY.—SHOT—*continued.*

| No. of Round.  | Elevation.   | Range. | Recoil. | 1st Graze. |        |       | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|----------------|--------------|--------|---------|------------|--------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|                |              |        |         | In Line.   | Right. | Left. |                                                                                                                                                         |          |              |       |    |       |    |
| July 11, 1864. |              |        |         |            |        |       |                                                                                                                                                         |          |              |       |    |       |    |
|                | °            | Yards. | Ft. In. |            | Yards. | Yard. |                                                                                                                                                         |          |              |       |    |       |    |
| 1              | 9            | 3,658  | —       | —          | 24.0   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 2              | "            | 3,692  | —       | —          | 21.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 3              | "            | 3,687  | —       | —          | 19.8   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 4              | "            | 3,678  | —       | —          | 21.2   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 5              | "            | 3,700  | —       | —          | 22.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 6              | "            | 3,706  | —       | —          | 20.0   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 7              | "            | 3,682  | —       | —          | 22.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 8              | "            | 3,686  | —       | —          | 21.8   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 9              | "            | 3,668  | —       | —          | 23.0   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 10             | "            | 3,670  | —       | —          | 23.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 11             | "            | 3,669  | —       | —          | 22.8   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 12             | "            | 3,664  | —       | —          | 22.2   | —     | The gun was 6 yards 2 feet left of line.                                                                                                                |          |              |       |    |       |    |
| 13             | "            | 3,618  | —       | —          | 23.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 14             | "            | 3,662  | —       | —          | 24.0   | —     | Weather :—Very slight haze, 10 a.m.                                                                                                                     |          |              |       |    |       |    |
| 15             | "            | 3,638  | —       | —          | 23.6   | —     | " " " 3 p.m.                                                                                                                                            |          |              |       |    |       |    |
| 16             | "            | 3,750  | —       | —          | 25.0   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 17             | "            | 3,660  | —       | —          | 25.4   | —     | Wind :—Direction, E. by S. ; force, 5 ; 10 a.m.                                                                                                         |          |              |       |    |       |    |
| 18             | "            | 3,740  | —       | —          | 22.6   | —     | " " " 5 ; 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 19             | "            | 3,658  | —       | —          | 26.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 20             | "            | 3,700  | —       | —          | 28.0   | —     | Thermometer :—68 dry, 67 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 21             | "            | 3,694  | —       | —          | 25.6   | —     | 71 " 70 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 22             | "            | 3,692  | —       | —          | 23.8   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 23             | "            | 3,705  | —       | —          | 27.2   | —     | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.22</td><td>67</td></tr><tr><td>30.15</td><td>66</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.22 | 67 | 30.15 | 66 |
| Reading.       | Temperature. |        |         |            |        |       |                                                                                                                                                         |          |              |       |    |       |    |
| 30.22          | 67           |        |         |            |        |       |                                                                                                                                                         |          |              |       |    |       |    |
| 30.15          | 66           |        |         |            |        |       |                                                                                                                                                         |          |              |       |    |       |    |
| 24             | "            | 3,715  | —       | —          | 23.8   | —     | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 25             | "            | 3,668  | —       | —          | 25.0   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 26             | "            | 3,708  | —       | —          | 27.2   | —     | Water was used twice during the practice.                                                                                                               |          |              |       |    |       |    |
| 27             | "            | 3,672  | —       | —          | 29.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 28             | "            | 3,690  | —       | —          | 27.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 29             | "            | 3,650  | —       | —          | 25.0   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 30             | "            | 3,750  | —       | —          | 30.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 31             | "            | 3,706  | —       | —          | 24.2   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 32             | "            | 3,750  | —       | —          | 26.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 33             | "            | 3,700  | —       | —          | 32.0   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 34             | "            | 3,723  | —       | —          | 25.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 35             | "            | 3,712  | —       | —          | 21.2   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 36             | "            | 3,709  | —       | —          | 24.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 37             | "            | 3,705  | —       | —          | 21.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 38             | "            | 3,740  | —       | —          | 32.0   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 39             | "            | 3,715  | —       | —          | 23.4   | —     | The shot stuck, and required several blows to ram home, at the 40th round.                                                                              |          |              |       |    |       |    |
| 40             | "            | 3,700  | —       | —          | 36.0   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| July 12, 1864. |              |        |         |            |        |       |                                                                                                                                                         |          |              |       |    |       |    |
| 1              | 15           | 5,200  | —       | —          | 96.0   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 2              | "            | 5,156  | —       | —          | 106.6  | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 3              | "            | 5,250  | —       | —          | 100.8  | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 4              | "            | 5,276  | —       | —          | 90.0   | —     | The gun was on the line.                                                                                                                                |          |              |       |    |       |    |
| 5              | "            | 5,248  | —       | —          | 92.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 6              | "            | 5,300  | —       | —          | 90.8   | —     | Weather :—Hazy on water, 10 a.m.                                                                                                                        |          |              |       |    |       |    |
| 7              | "            | 5,296  | —       | —          | 89.4   | —     | Clear, 3 p.m.                                                                                                                                           |          |              |       |    |       |    |
| 8              | "            | 5,250  | —       | —          | 94.0   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 9              | "            | 5,350  | —       | —          | 86.0   | —     | Wind :—Direction, N.E. ; force, 2 ; 10 a.m.                                                                                                             |          |              |       |    |       |    |
| 10             | "            | 5,340  | —       | —          | 85.4   | —     | " E. by S. ; " 4 ; 3 p.m.                                                                                                                               |          |              |       |    |       |    |
| 11             | "            | 5,342  | —       | —          | 84.0   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 12             | "            | 5,315  | —       | —          | 87.4   | —     | Thermometer :—60 dry, 59 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 13             | "            | 5,300  | —       | —          | 80.0   | —     | 64 " 61 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 14             | "            | 5,298  | —       | —          | 88.6   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 15             | "            | 5,325  | —       | —          | 86.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 16             | "            | 5,367  | —       | —          | 95.8   | —     | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.15</td><td>62</td></tr><tr><td>30.23</td><td>65</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.15 | 62 | 30.23 | 65 |
| Reading.       | Temperature. |        |         |            |        |       |                                                                                                                                                         |          |              |       |    |       |    |
| 30.15          | 62           |        |         |            |        |       |                                                                                                                                                         |          |              |       |    |       |    |
| 30.23          | 65           |        |         |            |        |       |                                                                                                                                                         |          |              |       |    |       |    |
| 17             | "            | 5,349  | —       | —          | 80.0   | —     | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 18             | "            | 5,298  | —       | —          | 79.4   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 19             | "            | 5,311  | —       | —          | 72.6   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 20             | "            | 5,280  | —       | —          | 84.8   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 21             | "            | 5,350  | —       | —          | 84.0   | —     |                                                                                                                                                         |          |              |       |    |       |    |
| 22             | "            | 5,367  | —       | —          | 83.8   | —     |                                                                                                                                                         |          |              |       |    |       |    |

## RANGE AND ACCURACY.—SHOT—continued.

| No. of Round. | Elevation. | Range. | Recoil. | 1st Graze. |        |        | Remarks.                                                  |
|---------------|------------|--------|---------|------------|--------|--------|-----------------------------------------------------------|
|               |            |        |         | In Line.   | Right. | Left.  |                                                           |
|               | °          | Yards. | Ft. In. |            | Yards. | Yards. |                                                           |
| 1             | 17         | 5,625  | —       | —          | 87.0   | —      | July 13, 1864.                                            |
| 2             | "          | 5,650  | —       | —          | 98.6   | —      |                                                           |
| 3             | "          | 5,456  | —       | —          | 82.2   | —      |                                                           |
| 4             | "          | 5,548  | —       | —          | 89.2   | —      |                                                           |
| 5             | "          | 5,551  | —       | —          | 88.2   | —      |                                                           |
| 6             | "          | 5,471  | —       | —          | 76.0   | —      | The gun was on the line.                                  |
| 7             | "          | 5,469  | —       | —          | 74.4   | —      | Weather :—Clear, 10 a.m.                                  |
| 8             | "          | 5,641  | —       | —          | 72.6   | —      | " 3 p.m.                                                  |
| 9             | "          | 5,594  | —       | —          | 68.8   | —      |                                                           |
| 10            | "          | 5,577  | —       | —          | 68.0   | —      | Wind :—Direction, N.E. by E.; force, 4; 10 a.m.           |
| 11            | "          | 5,594  | —       | —          | 80.4   | —      | " E. by S.; " 5; 3 p.m.                                   |
| 12            | "          | 5,548  | —       | —          | 79.6   | —      |                                                           |
| 13            | "          | 5,592  | —       | —          | 77.0   | —      | Thermometer :—62 dry, 60 wet, 10 a.m.                     |
| 14            | "          | 5,595  | —       | —          | 74.4   | —      | 65 " 62 " 3 p.m.                                          |
| 15            | "          | 5,508  | —       | —          | 75.4   | —      |                                                           |
| 16            | "          | 5,557  | —       | —          | 73.4   | —      | Barometer :—<br>Reading. Temperature.<br>30.05 65 10 a.m. |
| 17            | "          | 5,592  | —       | —          | 78.2   | —      | 30.10 60 3 p.m.                                           |
| 18            | "          | 5,505  | —       | —          | 80.8   | —      |                                                           |
| 19            | "          | 5,498  | —       | —          | 75.4   | —      |                                                           |
| 20            | "          | 5,514  | —       | —          | 75.0   | —      |                                                           |
| 21            | "          | 5,518  | —       | —          | 62.6   | —      |                                                           |
| 22            | "          | 5,483  | —       | —          | 68.0   | —      |                                                           |
|               |            |        |         |            |        |        | July 13, 1864.                                            |
| 1             | 19         | 5,948  | —       | —          | 77.2   | —      |                                                           |
| 2             | "          | 5,959  | —       | —          | 74.8   | —      |                                                           |
| 3             | "          | 5,998  | —       | —          | 87.8   | —      |                                                           |
| 4             | "          | 5,952  | —       | —          | 83.0   | —      |                                                           |
| 5             | "          | 5,895  | —       | —          | 79.8   | —      |                                                           |
| 6             | "          | 5,953  | —       | —          | 85.2   | —      | The gun was on the line.                                  |
| 7             | "          | 6,012  | —       | —          | 94.4   | —      |                                                           |
| 8             | "          | 6,004  | —       | —          | 94.4   | —      |                                                           |
| 9             | "          | 5,898  | —       | —          | 82.2   | —      |                                                           |
| 10            | "          | 5,945  | —       | —          | 84.6   | —      |                                                           |
| 11            | "          | 6,005  | —       | —          | 82.6   | —      |                                                           |
|               |            |        |         |            |        |        | July 14, 1864.                                            |
| 1             | 19         | 6,122  | —       | —          | 81.2   | —      |                                                           |
| 2             | "          | 6,150  | —       | —          | 82.4   | —      |                                                           |
| 3             | "          | 6,094  | —       | —          | 79.2   | —      | The gun was on the line.                                  |
| 4             | "          | 6,000  | —       | —          | 82.0   | —      | Weather :—Clear, 10 a.m.                                  |
| 5             | "          | 6,006  | —       | —          | 79.4   | —      | " 3 p.m.                                                  |
| 6             | "          | 6,086  | —       | —          | 81.2   | —      |                                                           |
| 7             | "          | 6,025  | —       | —          | 87.4   | —      | Wind :—Direction, E. by S.; force, 5; 10 a.m.             |
| 8             | "          | 6,061  | —       | —          | 93.0   | —      | " S.E. by S.; " 2; 3 p.m.                                 |
| 9             | "          | 6,100  | —       | —          | 82.8   | —      |                                                           |
| 10            | "          | 6,091  | —       | —          | 85.2   | —      |                                                           |
| 11            | "          | 6,050  | —       | —          | 88.0   | —      |                                                           |
| 12            | "          | 6,053  | —       | —          | 76.4   | —      |                                                           |
|               |            |        |         |            |        |        | July 14, 1864.                                            |
| 1             | 21         | 6,500  | —       | —          | 88.0   | —      |                                                           |
| 2             | "          | 6,450  | —       | —          | 86.4   | —      |                                                           |
| 3             | "          | 6,486  | —       | —          | 99.2   | —      |                                                           |
| 4             | "          | 6,463  | —       | —          | 79.4   | —      |                                                           |
| 5             | "          | 6,456  | —       | —          | 94.0   | —      |                                                           |
| 6             | "          | 6,496  | —       | —          | 87.4   | —      |                                                           |
| 7             | "          | 6,515  | —       | —          | 77.6   | —      |                                                           |
| 8             | "          | 6,488  | —       | —          | 89.4   | —      | The gun was on the line.                                  |
| 9             | "          | 6,465  | —       | —          | 84.4   | —      |                                                           |
| 10            | "          | 6,512  | —       | —          | 91.2   | —      | Thermometer :—60 dry, 57 wet, 10 a.m.                     |
| 11            | "          | 6,442  | —       | —          | 92.0   | —      | 67 " 63 " 3 p.m.                                          |
| 12            | "          | 6,293  | —       | —          | 85.4   | —      |                                                           |
| 13            | "          | 6,407  | —       | —          | 85.0   | —      | Barometer :—<br>Reading. Temperature.<br>30.20 63 10 a.m. |
| 14            | "          | 6,392  | —       | —          | 79.2   | —      | 30.22 62 3 p.m.                                           |
| 15            | "          | 6,470  | —       | —          | 85.4   | —      |                                                           |
| 16            | "          | 6,514  | —       | —          | 92.6   | —      |                                                           |
| 17            | "          | 6,461  | —       | —          | 87.0   | —      |                                                           |
| 18            | "          | 6,494  | —       | —          | 93.4   | —      |                                                           |
| 19            | "          | 6,518  | —       | —          | 92.2   | —      |                                                           |
| 20            | "          | 6,527  | —       | —          | 88.8   | —      |                                                           |
| 21            | "          | 6,450  | —       | —          | 90.0   | —      |                                                           |
| 22            | "          | 6,492  | —       | —          | 95.4   | —      |                                                           |

## RANGE AND ACCURACY.—SHOT—continued.

| No. of Round. | Elevation. | Range. | Recoil. | 1st Graze. |        |        | Remarks.                                        |
|---------------|------------|--------|---------|------------|--------|--------|-------------------------------------------------|
|               |            |        |         | In Line.   | Right. | Left.  |                                                 |
|               | °          | Yards. | Ft. in. |            | Yards. | Yards. | <i>September 22, 1864.</i>                      |
| 1             | 5          | 2,419  | —       | —          | 7.0    | —      |                                                 |
| 2             | "          | 2,421  | —       | —          | 8.4    | —      |                                                 |
| 3             | "          | 2,398  | —       | —          | 4.0    | —      |                                                 |
| 4             | "          | 2,412  | —       | —          | 9.0    | —      |                                                 |
| 5             | "          | 2,454  | —       | —          | 9.4    | —      | The gun was on the line.                        |
| 6             | "          | 2,415  | —       | —          | 5.4    | —      |                                                 |
| 7             | "          | 2,382  | —       | —          | 2.2    | —      | Weather :—Clear.                                |
| 8             | "          | 2,397  | —       | —          | 3.6    | —      |                                                 |
| 9             | "          | 2,407  | —       | —          | 9.0    | —      | Wind :—Direction, S.W. by W.; force, 3; 10 a.m. |
| 10            | "          | 2,468  | —       | —          | 7.4    | —      | " W.S.W.; " 4; 3 p.m.                           |
| 11            | "          | 2,453  | —       | —          | 10.6   | —      |                                                 |
| 12            | "          | 2,428  | —       | —          | 4.4    | —      | Thermometer :—61 dry, 58 wet, 10 a.m.           |
| 13            | "          | 2,408  | —       | —          | 5.8    | —      | 67 " 59 " 3 p.m.                                |
| 14            | "          | 2,452  | —       | —          | 5.6    | —      |                                                 |
| 15            | "          | 2,419  | —       | —          | 8.8    | —      | Barometer :—Reading. Temperature.               |
| 16            | "          | 2,433  | —       | —          | 8.0    | —      | 29.85 61 10 a.m.                                |
| 17            | "          | 2,435  | —       | —          | 6.0    | —      | 29.85 64 3 p.m.                                 |
| 18            | "          | 2,434  | —       | —          | 5.4    | —      |                                                 |
| 19            | "          | 2,446  | —       | —          | 8.6    | —      |                                                 |
| 20            | "          | 2,412  | —       | —          | 8.0    | —      |                                                 |
|               |            |        |         |            |        |        |                                                 |
| 1             | 8          | 3,438  | —       | —          | 25.0   | —      |                                                 |
| 2             | "          | 3,465  | —       | —          | 28.0   | —      |                                                 |
| 3             | "          | 3,507  | —       | —          | 28.0   | —      |                                                 |
| 4             | "          | 3,500  | —       | —          | 20.0   | —      |                                                 |
| 5             | "          | 3,500  | —       | —          | 22.0   | —      |                                                 |
| 6             | "          | 3,437  | —       | —          | 21.4   | —      |                                                 |
| 7             | "          | 3,512  | —       | —          | 26.0   | —      |                                                 |
| 8             | "          | 3,506  | —       | —          | 22.0   | —      |                                                 |
| 9             | "          | 3,482  | —       | —          | 26.0   | —      |                                                 |
| 10            | "          | 3,555  | —       | —          | 27.0   | —      |                                                 |
| 11            | "          | 3,495  | —       | —          | 26.8   | —      |                                                 |
| 12            | "          | 3,491  | —       | —          | 23.6   | —      |                                                 |
| 13            | "          | 3,506  | —       | —          | 23.0   | —      |                                                 |
| 14            | "          | 3,476  | —       | —          | 24.0   | —      |                                                 |
| 15            | "          | 3,466  | —       | —          | 24.0   | —      |                                                 |
| 16            | "          | 3,454  | —       | —          | 25.6   | —      |                                                 |
| 17            | "          | 3,574  | —       | —          | 28.0   | —      |                                                 |
| 18            | "          | 3,518  | —       | —          | 26.4   | —      |                                                 |
| 19            | "          | 3,518  | —       | —          | 20.0   | —      |                                                 |
| 20            | "          | 3,550  | —       | —          | 20.0   | —      |                                                 |

RANGE AND ACCURACY—*continued.*

## COMMON SHELL (WEIGHTED WITH SAND).

SHOEBURYNESS.

*Particulars of Shell and Ammunition.*

Weight, 69.75 lbs.

Diameter, 6.34 in.

Length, 14.64 in.

Bursting charge, 4.75 lbs.

No. of studs, 18 in 3 rows.

Breadth of studs at top, .45 in.

" " " bottom, .59 in.

| No. of Round. | Elevation.   | Range. | 1st Graze. |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|---------------|--------------|--------|------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |              |        | In Line.   | Right. |                                                                                                                                                         |          |              |       |    |       |    |
|               | °            | Yards. |            | Yards. | September 7, 1864.                                                                                                                                      |          |              |       |    |       |    |
| 1             | 4            | 2,073  | —          | 5.0    |                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "            | 2,141  | —          | 9.2    |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "            | 2,158  | —          | 8.2    |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "            | 2,152  | —          | 10.0   |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "            | 2,134  | —          | 7.0    |                                                                                                                                                         |          |              |       |    |       |    |
| 6             | "            | 2,149  | —          | 8.6    |                                                                                                                                                         |          |              |       |    |       |    |
| 7             | "            | 2,150  | —          | 9.4    |                                                                                                                                                         |          |              |       |    |       |    |
| 8             | "            | 2,136  | —          | 6.8    |                                                                                                                                                         |          |              |       |    |       |    |
| 9             | "            | 2,143  | —          | 10.6   |                                                                                                                                                         |          |              |       |    |       |    |
| 10            | "            | 2,108  | —          | 7.2    |                                                                                                                                                         |          |              |       |    |       |    |
| 11            | "            | 2,146  | —          | 9.4    |                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "            | 2,157  | —          | 13.0   |                                                                                                                                                         |          |              |       |    |       |    |
| 13            | "            | 2,160  | —          | 9.6    | The gun was on the line.                                                                                                                                |          |              |       |    |       |    |
| 14            | "            | 2,183  | —          | 10.0   |                                                                                                                                                         |          |              |       |    |       |    |
| 15            | "            | 2,131  | —          | 7.2    | Weather :—Very hazy, 10 a.m.                                                                                                                            |          |              |       |    |       |    |
| 16            | "            | 2,128  | —          | 8.0    | Hazy, 3 p.m.                                                                                                                                            |          |              |       |    |       |    |
| 17            | "            | 2,161  | —          | 11.0   |                                                                                                                                                         |          |              |       |    |       |    |
| 18            | "            | 2,132  | —          | 9.0    | Wind :—Direction, N.W. by W. ; force, 3 ; 10 a.m.                                                                                                       |          |              |       |    |       |    |
| 19            | "            | 2,137  | —          | 9.0    | " " " 2 ; 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 20            | "            | 2,116  | —          | 9.2    |                                                                                                                                                         |          |              |       |    |       |    |
| 21            | "            | 2,174  | —          | 9.4    | Thermometer :—67 dry, 66 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 22            | "            | 2,134  | —          | 8.8    | 69 " 67 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 23            | "            | 2,150  | —          | 8.4    |                                                                                                                                                         |          |              |       |    |       |    |
| 24            | "            | 2,142  | —          | 12.2   |                                                                                                                                                         |          |              |       |    |       |    |
| 25            | "            | 2,144  | —          | 8.6    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>30.05</td><td>64</td></tr><tr><td>30.05</td><td>66</td></tr></table> 10 a.m. | Reading. | Temperature. | 30.05 | 64 | 30.05 | 66 |
| Reading.      | Temperature. |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30.05         | 64           |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 30.05         | 66           |        |            |        |                                                                                                                                                         |          |              |       |    |       |    |
| 26            | "            | 2,141  | —          | 8.2    | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 27            | "            | 2,159  | —          | 9.0    |                                                                                                                                                         |          |              |       |    |       |    |
| 28            | "            | 2,143  | —          | 10.2   |                                                                                                                                                         |          |              |       |    |       |    |
| 29            | "            | 2,141  | —          | 10.2   |                                                                                                                                                         |          |              |       |    |       |    |
| 30            | "            | 2,133  | —          | 10.0   |                                                                                                                                                         |          |              |       |    |       |    |
| 31            | "            | 2,179  | —          | 8.8    |                                                                                                                                                         |          |              |       |    |       |    |
| 32            | "            | 2,136  | —          | 10.6   |                                                                                                                                                         |          |              |       |    |       |    |
| 33            | "            | 2,165  | —          | 10.8   |                                                                                                                                                         |          |              |       |    |       |    |
| 34            | "            | 2,111  | —          | 10.8   |                                                                                                                                                         |          |              |       |    |       |    |
| 35            | "            | 2,146  | —          | 8.8    |                                                                                                                                                         |          |              |       |    |       |    |
| 36            | "            | 2,150  | —          | 10.0   |                                                                                                                                                         |          |              |       |    |       |    |
| 37            | "            | 2,142  | —          | 9.0    |                                                                                                                                                         |          |              |       |    |       |    |
| 38            | "            | 2,160  | —          | 10.8   |                                                                                                                                                         |          |              |       |    |       |    |
| 39            | "            | 2,186  | —          | 11.0   |                                                                                                                                                         |          |              |       |    |       |    |
| 40            | "            | 2,135  | —          | 10.0   |                                                                                                                                                         |          |              |       |    |       |    |
| 41            | "            | 2,120  | —          | 9.2    |                                                                                                                                                         |          |              |       |    |       |    |



RANGE AND ACCURACY.—COMMON SHELL—continued.

| No. of Round. | Eleva- tion. | Range. | 1st Graze. |        | Remarks.                                |
|---------------|--------------|--------|------------|--------|-----------------------------------------|
|               |              |        | In Line.   | Right. |                                         |
|               | °            | Yards. |            | Yards. | September 9, 1864.                      |
| 1             | 7            | 3,306  | —          | 7.4    |                                         |
| 2             | "            | 3,371  | —          | 3.2    |                                         |
| 3             | "            | 3,363  | —          | 5.4    |                                         |
| 4             | "            | 3,358  | —          | 12.0   |                                         |
| 5             | "            | 3,345  | —          | 8.4    |                                         |
| 6             | "            | 3,324  | —          | 8.4    |                                         |
| 7             | "            | 3,351  | —          | 11.2   |                                         |
| 8             | "            | 3,387  | —          | 9.4    |                                         |
| 9             | "            | 3,348  | —          | 9.2    |                                         |
| 10            | "            | 3,382  | —          | 7.6    |                                         |
| 11            | "            | 3,348  | —          | 5.6    |                                         |
| 12            | "            | 3,393  | —          | 6.6    |                                         |
| 13            | "            | 3,388  | —          | 4.0    | The gun was on the line.                |
| 14            | "            | 3,336  | —          | 5.0    |                                         |
| 15            | "            | 3,306  | —          | 3.2    | Weather :—Clear, 10 a.m.                |
| 16            | "            | 3,440  | —          | 6.0    | Slight haze, 3 p.m.                     |
| 17            | "            | 3,381  | —          | 5.4    |                                         |
| 18            | "            | 3,388  | —          | 7.8    | Wind :—Direction, W.; force, 5; 10 a.m. |
| 19            | "            | 3,339  | —          | 6.0    | " " " 7; 3 p.m.                         |
| 20            | "            | 3,370  | —          | 5.6    |                                         |
| 21            | "            | 3,324  | —          | 7.8    |                                         |
| 22            | "            | 3,340  | —          | 8.2    |                                         |
| 23            | "            | 3,325  | —          | 9.4    |                                         |
| 24            | "            | 3,316  | —          | 5.6    | Thermometer :—68 dry, 65 wet, 10 a.m.   |
| 25            | "            | 3,368  | —          | 6.6    | 69 " 66 " 3 p.m.                        |
| 26            | "            | 3,336  | —          | 6.8    |                                         |
| 27            | "            | 3,349  | —          | 4.8    |                                         |
| 28            | "            | 3,338  | Yes.       | —      | Reading. Temperature.                   |
| 29            | "            | 3,322  | —          | 1.0    | Barometer :—30.05 66 10 a.m.            |
| 30            | "            | 3,368  | —          | 4.2    | 29.95 67 3 p.m.                         |
| 31            | "            | 3,324  | —          | 5.6    |                                         |
| 32            | "            | 3,397  | —          | 10.0   |                                         |
| 33            | "            | 3,323  | —          | 7.2    |                                         |
| 34            | "            | 3,339  | —          | 6.6    |                                         |
| 35            | "            | 3,302  | —          | 6.0    |                                         |
| 36            | "            | 3,378  | —          | 4.6    |                                         |
| 37            | "            | 3,377  | —          | 8.0    |                                         |
| 38            | "            | 3,315  | —          | 2.6    |                                         |
| 39            | "            | 3,281  | —          | 2.6    |                                         |
| 40            | "            | 3,318  | —          | 4.0    |                                         |
| 41            | "            | 3,332  | —          | 2.6    |                                         |
| 42            | "            | 3,307  | —          | 4.0    |                                         |
| 43            | "            | 3,310  | —          | 4.8    |                                         |
| 44            | "            | 3,257  | —          | 7.0    |                                         |



## RANGE AND ACCURACY—continued.

## SEGMENT SHELL (WEIGHTED WITH SAND).

SHOEBURYNESS

*Particulars of Shell and Ammunition.*

Weight, 68·9 lbs.  
Diameter, 6'34 in.  
Length, 13'88 in.  
No. of segments, 98.

Bursting charge, 1 lb.  
No. of studs, 15, in 3 rows.  
Breadth of do. at top, ·45 in.  
Do. at bottom, ·59 in.

| No. of Round. | Eleva-<br>tion. | Range. | 1st Graze. |        |        | Remarks.                                                                                                                                                |          |              |       |    |       |    |
|---------------|-----------------|--------|------------|--------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|-------|----|-------|----|
|               |                 |        | In Line.   | Right. | Left.  |                                                                                                                                                         |          |              |       |    |       |    |
|               | °               | Yards. |            | Yards. | Yards. | June 30, 1864.                                                                                                                                          |          |              |       |    |       |    |
| 1             | 2               | —      | —          | —      | —      |                                                                                                                                                         |          |              |       |    |       |    |
| 2             | "               | 1,350  | —          | —      | 5·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 3             | "               | 1,349  | —          | —      | 4·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 4             | "               | 1,314  | —          | —      | 3·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 5             | "               | 1,341  | —          | —      | 1·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 6             | "               | 1,309  | —          | —      | 3·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 7             | "               | 1,296  | —          | —      | 3·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 8             | "               | 1,337  | —          | —      | 4·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 9             | "               | 1,398  | —          | —      | 2·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 10            | "               | 1,340  | —          | —      | 3·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 11            | "               | 1,270  | —          | —      | 4·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 12            | "               | 1,286  | —          | —      | 4·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 13            | "               | 1,284  | —          | —      | 2·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 14            | "               | 1,269  | —          | —      | 4·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 15            | "               | 1,352  | —          | —      | 4·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 16            | "               | 1,357  | —          | —      | 3·4    | The gun was 6 yards 2 feet left of line.                                                                                                                |          |              |       |    |       |    |
| 17            | "               | 1,332  | —          | —      | 2·6    | Weather :—Clear, 10 a.m.                                                                                                                                |          |              |       |    |       |    |
| 18            | "               | 1,255  | —          | —      | 4·2    | Slight haze, 3 p.m.                                                                                                                                     |          |              |       |    |       |    |
| 19            | "               | 1,318  | —          | —      | 2·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 20            | "               | 1,293  | —          | —      | 3·4    | Wind :—Direction, N. W. by N. ; force, 5 ; 10 a.m.                                                                                                      |          |              |       |    |       |    |
| 21            | "               | 1,321  | —          | —      | 2·0    | " " " 4 ; 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 22            | "               | 1,282  | —          | —      | 4·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 23            | "               | 1,369  | —          | —      | 3·4    | Thermometer :—63 dry, 60 wet, 10 a.m.                                                                                                                   |          |              |       |    |       |    |
| 24            | "               | 1,268  | —          | —      | 3·6    | 68 " 62 " 3 p.m.                                                                                                                                        |          |              |       |    |       |    |
| 25            | "               | 1,309  | —          | —      | 4·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 26            | "               | 1,355  | —          | —      | 3·6    | Barometer :— <table><tr><td>Reading.</td><td>Temperature.</td></tr><tr><td>29·95</td><td>61</td></tr><tr><td>22·95</td><td>64</td></tr></table> 10 a.m. | Reading. | Temperature. | 29·95 | 61 | 22·95 | 64 |
| Reading.      | Temperature.    |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 29·95         | 61              |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 22·95         | 64              |        |            |        |        |                                                                                                                                                         |          |              |       |    |       |    |
| 27            | "               | 1,252  | —          | —      | 4·4    | 3 p.m.                                                                                                                                                  |          |              |       |    |       |    |
| 28            | "               | 1,252  | —          | —      | 4·0    |                                                                                                                                                         |          |              |       |    |       |    |
| 29            | "               | 1,258  | —          | —      | 4·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 30            | "               | 1,333  | —          | —      | 4·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 31            | "               | 1,340  | —          | —      | 3·6    |                                                                                                                                                         |          |              |       |    |       |    |
| 32            | "               | 1,331  | —          | —      | 3·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 33            | "               | 1,332  | —          | —      | 4·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 34            | "               | 1,297  | —          | —      | 4·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 35            | "               | 1,342  | —          | —      | 5·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 36            | "               | 1,334  | —          | —      | 4·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 37            | "               | 1,344  | —          | —      | 4·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 38            | "               | 1,306  | —          | —      | 5·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 39            | "               | 1,300  | —          | —      | 3·8    |                                                                                                                                                         |          |              |       |    |       |    |
| 40            | "               | 1,336  | —          | —      | 4·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 41            | "               | 1,337  | —          | —      | 4·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 42            | "               | 1,297  | —          | —      | 5·4    |                                                                                                                                                         |          |              |       |    |       |    |
| 43            | "               | 1,317  | —          | —      | 4·2    |                                                                                                                                                         |          |              |       |    |       |    |
| 44            | "               | 1,248  | —          | —      | 2·6    |                                                                                                                                                         |          |              |       |    |       |    |



RANGE AND ACCURACY.—SEGMENT SHELL—*continued.*

| No. of Round. | Elevation. | Range. | 1st Graze. |        |        | Remarks.                   |
|---------------|------------|--------|------------|--------|--------|----------------------------|
|               |            |        | In Line.   | Right. | Left.  |                            |
|               |            | Yards. |            | Yards. | Yards. |                            |
| 1             | 8          | 3,586  | —          | 6.2    | —      | <i>September 13, 1864.</i> |
| 2             | "          | 3,509  | Yes.       | —      | —      |                            |
| 3             | "          | 3,548  | —          | 14.6   | —      |                            |
| 4             | "          | 3,564  | —          | 12.2   | —      |                            |
| 5             | "          | 3,522  | —          | 1.6    | —      |                            |
| 6             | "          | 3,610  | —          | 12.2   | —      |                            |
| 7             | "          | 3,624  | —          | 5.2    | —      |                            |
| 8             | "          | 3,604  | —          | 6.0    | —      |                            |
| 9             | "          | 3,270  | Yes.       | —      | —      |                            |
| 10            | "          | 3,339  | —          | 8.6    | —      |                            |
| 11            | "          | 3,561  | —          | 6.2    | —      |                            |
| 12            | "          | 3,278  | —          | 10.4   | —      |                            |
| 13            | "          | 3,537  | —          | 12.6   | —      |                            |
| 14            | "          | 3,568  | —          | 15.4   | —      |                            |
| 15            | "          | 3,406  | —          | 14.0   | —      |                            |
| 16            | "          | 3,567  | —          | 13.4   | —      |                            |
| 17            | "          | 3,548  | —          | 2.6    | —      |                            |
| 18            | "          | 3,653  | —          | 6.0    | —      |                            |
| 19            | "          | 3,615  | —          | 5.2    | —      |                            |
| 20            | "          | 3,578  | —          | 9.4    | —      |                            |
| 21            | "          | 3,565  | —          | 2.0    | —      |                            |
| 22            | "          | 3,581  | —          | 0.4    | —      |                            |
| 23            | "          | 3,512  | —          | 10.2   | —      |                            |
| 24            | "          | 3,576  | —          | 2.0    | —      |                            |
| 25            | "          | 3,610  | —          | 10.0   | —      |                            |
| 26            | "          | 3,519  | —          | 6.4    | —      |                            |
| 27            | "          | 3,625  | —          | 5.0    | —      |                            |
| 28            | "          | 3,584  | —          | 5.4    | —      |                            |
| 29            | "          | 3,538  | —          | 8.4    | —      |                            |
| 30            | "          | 3,540  | Yes.       | —      | —      |                            |
| 31            | "          | 3,504  | —          | 2.0    | —      |                            |
| 32            | "          | 3,537  | —          | 9.0    | —      |                            |
| 33            | "          | 3,505  | —          | 5.4    | —      |                            |
| 34            | "          | 3,531  | —          | 3.4    | —      |                            |
| 35            | "          | 3,575  | —          | 3.2    | —      |                            |
| 36            | "          | 3,546  | Yes.       | —      | —      |                            |
| 37            | "          | 3,548  | —          | —      | 2.0    |                            |
| 38            | "          | 3,512  | —          | 3.4    | —      |                            |
| 39            | "          | 3,493  | —          | 2.4    | —      |                            |
| 40            | "          | 3,527  | —          | 3.6    | —      |                            |
| 41            | "          | 3,493  | —          | 5.4    | —      |                            |
| 42            | "          | 3,337  | —          | 8.0    | —      |                            |
| 43            | "          | 3,484  | —          | 1.6    | —      |                            |
| 44            | "          | 3,518  | —          | 5.0    | —      |                            |

The gun was on the line.  
Weather :—Clear.  
Wind :—Direction, W.S.W. ; force, 3 ; 10 a.m.  
" S.W. by S. " 5 ; 3 p.m.  
Thermometer :—60 dry, 59 wet, 10 a.m.  
62 " 60 " 3 p.m.  
Barometer :—

|          |              |         |
|----------|--------------|---------|
| Reading. | Temperature. |         |
| 30.05    | 58           | 10 a.m. |
| 29.95    | 61           | 3 p.m.  |

## DESTRUCTIVE EFFECT.

## SEGMENT SHELL FIRED TO BURST ON GRAZE.

November 14, 1864.

RANGE, 800 yards.

*Note.*—This practice was carried on with the 3 lb. burster, which Sir W. Asmstrong intended only for sea service, Sir W. Armstrong not having specified a reduced bursting charge for land service.

Firing carried on against three lines of 2-inch targets 9 feet square, six targets in each line, 10 yards interval between the lines. In the marsh.

|                         |           | Through. | Lodged. | Struck. |                        |           | Through. | Lodged. | Struck. |
|-------------------------|-----------|----------|---------|---------|------------------------|-----------|----------|---------|---------|
| Struck 121 yards short. | 1st line. |          |         |         | Struck 26 yards short. | 1st line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                        | 1 target  | 0        | 0       | 1       |
|                         | 2 "       | 2        | 1       | 0       |                        | 2 "       | 22       | 3       | 5       |
|                         | 3 "       | 3        | 0       | 0       |                        | 3 "       | 0        | 0       | 0       |
|                         | 4 "       | 1        | 0       | 0       |                        | 4 "       | 0        | 0       | 0       |
|                         | 5 "       | 1        | 0       | 0       |                        | 5 "       | 0        | 0       | 0       |
|                         | 6 "       | 0        | 0       | 0       |                        | 6 "       | 0        | 0       | 0       |
|                         | 2nd line. |          |         |         |                        | 2nd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 1       |                        | 1 target  | 0        | 1       | 1       |
|                         | 2 "       | 0        | 0       | 0       |                        | 2 "       | 10       | 1       | 2       |
|                         | 3 "       | 2        | 1       | 0       |                        | 3 "       | 1        | 0       | 2       |
|                         | 4 "       | 0        | 0       | 0       |                        | 4 "       | 0        | 0       | 0       |
|                         | 5 "       | 0        | 0       | 0       |                        | 5 "       | 0        | 0       | 0       |
|                         | 6 "       | 0        | 0       | 0       |                        | 6 "       | 0        | 0       | 0       |
|                         | 3rd line. |          |         |         |                        | 3rd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                        | 1 target  | 0        | 0       | 0       |
|                         | 2 "       | 0        | 0       | 0       |                        | 2 "       | 4        | 5       | 1       |
|                         | 3 "       | 1        | 0       | 0       |                        | 3 "       | 0        | 0       | 0       |
|                         | 4 "       | 0        | 0       | 0       |                        | 4 "       | 0        | 0       | 1       |
|                         | 5 "       | 0        | 0       | 0       |                        | 5 "       | 1        | 0       | 3       |
|                         | 6 "       | 0        | 0       | 0       |                        | 6 "       | 0        | 0       | 0       |
| Struck 64 yards short.  | 1st line. |          |         |         | Struck 23 yards short. | 1st line. |          |         |         |
|                         | 1 target  | 0        | 0       | 1       |                        | 1 target  | 0        | 0       | 0       |
|                         | 2 "       | 0        | 1       | 0       |                        | 2 "       | 1        | 0       | 0       |
|                         | 3 "       | 1        | 1       | 0       |                        | 3 "       | 3        | 0       | 1       |
|                         | 4 "       | 0        | 1       | 0       |                        | 4 "       | 1        | 1       | 0       |
|                         | 5 "       | 2        | 0       | 0       |                        | 5 "       | 1        | 0       | 0       |
|                         | 6 "       | 1        | 0       | 0       |                        | 6 "       | 1        | 0       | 0       |
|                         | 2nd line. |          |         |         |                        | 2nd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                        | 1 target  | 2        | 0       | 3       |
|                         | 2 "       | 0        | 0       | 0       |                        | 2 "       | 0        | 0       | 1       |
|                         | 3 "       | 3        | 0       | 0       |                        | 3 "       | 1        | 0       | 0       |
|                         | 4 "       | 0        | 0       | 0       |                        | 4 "       | 0        | 0       | 0       |
|                         | 5 "       | 0        | 0       | 0       |                        | 5 "       | 0        | 0       | 0       |
|                         | 6 "       | 1        | 0       | 0       |                        | 6 "       | 0        | 0       | 0       |
|                         | 3rd line. |          |         |         |                        | 3rd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                        | 1 target  | 0        | 0       | 0       |
|                         | 2 "       | 0        | 0       | 0       |                        | 2 "       | 0        | 0       | 0       |
|                         | 3 "       | 0        | 0       | 0       |                        | 3 "       | 0        | 2       | 0       |
|                         | 4 "       | 0        | 0       | 0       |                        | 4 "       | 0        | 0       | 0       |
|                         | 5 "       | 1        | 0       | 0       |                        | 5 "       | 0        | 0       | 0       |
|                         | 6 "       | 0        | 0       | 0       |                        | 6 "       | 0        | 0       | 0       |
| Struck 26 yards short.  | 1st line. |          |         |         | Struck 24 yards short. | 1st line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                        | 1 target  | 0        | 0       | 0       |
|                         | 2 "       | 1        | 0       | 0       |                        | 2 "       | 0        | 0       | 0       |
|                         | 3 "       | 0        | 2       | 1       |                        | 3 "       | 1        | 2       | 1       |
|                         | 4 "       | 3        | 0       | 0       |                        | 4 "       | 6        | 1       | 0       |
|                         | 5 "       | 0        | 0       | 0       |                        | 5 "       | 0        | 0       | 0       |
|                         | 6 "       | 0        | 0       | 0       |                        | 6 "       | 0        | 0       | 0       |
|                         | 2nd line. |          |         |         |                        | 2nd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                        | 1 target  | 1        | 0       | 0       |
|                         | 2 "       | 1        | 0       | 0       |                        | 2 "       | 0        | 0       | 0       |
|                         | 3 "       | 0        | 0       | 0       |                        | 3 "       | 0        | 0       | 0       |
|                         | 4 "       | 2        | 0       | 0       |                        | 4 "       | 0        | 0       | 0       |
|                         | 5 "       | 2        | 0       | 1       |                        | 5 "       | 1        | 0       | 0       |
|                         | 6 "       | 0        | 0       | 0       |                        | 6 "       | 3        | 0       | 0       |
|                         | 3rd line. |          |         |         |                        | 3rd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                        | 1 target  | 0        | 0       | 0       |
|                         | 2 "       | 0        | 1       | 0       |                        | 2 "       | 0        | 0       | 0       |
|                         | 3 "       | 0        | 0       | 0       |                        | 3 "       | 0        | 0       | 0       |
|                         | 4 "       | 1        | 2       | 0       |                        | 4 "       | 0        | 0       | 0       |
|                         | 5 "       | 0        | 0       | 0       |                        | 5 "       | 0        | 0       | 0       |
|                         | 6 "       | 0        | 0       | 0       |                        | 6 "       | 2        | 0       | 0       |

Five blind shell.

DESTRUCTIVE EFFECT.—SEGMENT SHELL—*continued.*

|                         |           | Through. | Lodged. | Struck. |                         |           | Through. | Lodged. | Struck. |
|-------------------------|-----------|----------|---------|---------|-------------------------|-----------|----------|---------|---------|
| Struck 70 yards short.  | 1st line. |          |         |         | Struck 79 yards short.  | 1st line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                         | 1 target  | 0        | 0       | 1       |
|                         | 2 "       | 0        | 0       | 1       |                         | 2 "       | 0        | 0       | 0       |
|                         | 3 "       | 0        | 0       | 0       |                         | 3 "       | 1        | 0       | 0       |
|                         | 4 "       | 0        | 0       | 0       |                         | 4 "       | 4        | 0       | 0       |
|                         | 5 "       | 1        | 0       | 0       |                         | 5 "       | 2        | 0       | 0       |
|                         | 6 "       | 2        | 0       | 0       |                         | 6 "       | 1        | 0       | 0       |
|                         | 2nd line. |          |         |         |                         | 2nd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                         | 1 target  | 0        | 0       | 0       |
|                         | 2 "       | 0        | 0       | 0       |                         | 2 "       | 0        | 0       | 0       |
|                         | 3 "       | 0        | 0       | 0       |                         | 3 "       | 0        | 0       | 0       |
|                         | 4 "       | 0        | 0       | 0       |                         | 4 "       | 0        | 2       | 0       |
|                         | 5 "       | 0        | 0       | 0       |                         | 5 "       | 1        | 1       | 0       |
|                         | 6 "       | 0        | 1       | 0       |                         | 6 "       | 1        | 0       | 0       |
|                         | 3rd line. |          |         |         |                         | 3rd line. |          |         |         |
|                         | 1 target  | Nil.     | Nil.    | Nil.    |                         | 1 target  | 0        | 0       | 0       |
|                         | 2 "       |          |         |         |                         | 2 "       | 1        | 0       | 0       |
|                         | 3 "       |          |         |         |                         | 3 "       | 0        | 0       | 0       |
|                         | 4 "       |          |         |         |                         | 4 "       | 0        | 0       | 0       |
|                         | 5 "       |          |         |         |                         | 5 "       | 0        | 0       | 1       |
|                         | 6 "       |          |         |         |                         | 6 "       | 0        | 0       | 0       |
| Struck 44 yards short.  | 1st line. |          |         |         | Struck 68 yards short.  | 1st line. |          |         |         |
|                         | 1 target  | 3        | 0       | 0       |                         | 1 target  | 1        | 0       | 0       |
|                         | 2 "       | 0        | 1       | 0       |                         | 2 "       | 0        | 0       | 0       |
|                         | 3 "       | 2        | 0       | 0       |                         | 3 "       | 1        | 0       | 0       |
|                         | 4 "       | 3        | 1       | 0       |                         | 4 "       | 0        | 0       | 0       |
|                         | 5 "       | 7        | 0       | 0       |                         | 5 "       | 0        | 0       | 0       |
|                         | 6 "       | 0        | 0       | 1       |                         | 6 "       | 3        | 0       | 0       |
|                         | 2nd line. |          |         |         |                         | 2nd line. |          |         |         |
|                         | 1 target  | 2        | 0       | 0       |                         | 1 target  | 0        | 0       | 0       |
|                         | 2 "       | 0        | 0       | 0       |                         | 2 "       | 0        | 1       | 0       |
|                         | 3 "       | 0        | 0       | 1       |                         | 3 "       | 0        | 0       | 0       |
|                         | 4 "       | 3        | 0       | 2       |                         | 4 "       | 0        | 0       | 0       |
|                         | 5 "       | 0        | 1       | 0       |                         | 5 "       | 0        | 0       | 0       |
|                         | 6 "       | 3        | 0       | 0       |                         | 6 "       | 0        | 0       | 0       |
|                         | 3rd line. |          |         |         |                         | 3rd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                         | 1 target  | Nil.     | Nil.    | Nil.    |
|                         | 2 "       | 0        | 0       | 0       |                         | 2 "       |          |         |         |
|                         | 3 "       | 1        | 0       | 0       |                         | 3 "       |          |         |         |
|                         | 4 "       | 1        | 0       | 0       |                         | 4 "       |          |         |         |
|                         | 5 "       | 0        | 0       | 0       |                         | 5 "       |          |         |         |
|                         | 6 "       | 0        | 1       | 0       |                         | 6 "       |          |         |         |
| Struck 122 yards short. | 1st line. |          |         |         | Struck 114 yards short. | 1st line. |          |         |         |
|                         | 1 target  | 0        | 0       | 1       |                         | 1 target  | 0        | 0       | 0       |
|                         | 2 "       | 0        | 1       | 0       |                         | 2 "       | 0        | 0       | 0       |
|                         | 3 "       | 0        | 0       | 1       |                         | 3 "       | 0        | 0       | 0       |
|                         | 4 "       | 0        | 0       | 1       |                         | 4 "       | 0        | 0       | 0       |
|                         | 5 "       | 0        | 1       | 0       |                         | 5 "       | 2        | 1       | 0       |
|                         | 6 "       | 0        | 0       | 0       |                         | 6 "       | 0        | 1       | 1       |
|                         | 2nd line. |          |         |         |                         | 2nd line. |          |         |         |
|                         | 1 target  | Nil.     | Nil.    | Nil.    |                         | 1 target  | 0        | 0       | 0       |
|                         | 2 "       |          |         |         |                         | 2 "       | 0        | 0       | 0       |
|                         | 3 "       |          |         |         |                         | 3 "       | 0        | 0       | 0       |
|                         | 4 "       |          |         |         |                         | 4 "       | 0        | 0       | 0       |
|                         | 5 "       |          |         |         |                         | 5 "       | 0        | 0       | 0       |
|                         | 6 "       |          |         |         |                         | 6 "       | 1        | 0       | 0       |
|                         | 3rd line. |          |         |         |                         | 3rd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                         | 1 target  | Nil.     | Nil.    | Nil.    |
|                         | 2 "       | 0        | 0       | 0       |                         | 2 "       |          |         |         |
|                         | 3 "       | 0        | 0       | 0       |                         | 3 "       |          |         |         |
|                         | 4 "       | 0        | 0       | 0       |                         | 4 "       |          |         |         |
|                         | 5 "       | 0        | 1       | 0       |                         | 5 "       |          |         |         |
|                         | 6 "       | 0        | 0       | 0       |                         | 6 "       |          |         |         |

Four blind shell during this day's practice.

November 15, 1864.

Four blind shell during this day's practice.

November 15, 1864.



## DESTRUCTIVE EFFECT.—SEGMENT SHELL—continued.

|                         |           | Through. | Lodged. | Struck. |                        |           | Through. | Lodged. | Struck. |
|-------------------------|-----------|----------|---------|---------|------------------------|-----------|----------|---------|---------|
| Struck 170 yards short. | 1st line. |          |         |         | Struck 52 yards short. | 1st line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                        | 1 target  | 1        | 0       | 0       |
|                         | 2 "       | 0        | 0       | 0       |                        | 2 "       | 0        | 0       | 1       |
|                         | 3 "       | 1        | 0       | 0       |                        | 3 "       | 1        | 0       | 0       |
|                         | 4 "       | 0        | 0       | 0       |                        | 4 "       | 1        | 0       | 0       |
|                         | 5 "       | 0        | 1       | 0       |                        | 5 "       | 1        | 0       | 1       |
|                         | 6 "       | 0        | 0       | 0       |                        | 6 "       | 5        | 0       | 0       |
|                         | 2nd line. |          |         |         |                        | 2nd line. |          |         |         |
|                         | 1 target  | Nil.     | Nil.    | Nil.    |                        | 1 target  | 1        | 0       | 0       |
|                         | 2 "       |          |         |         |                        | 2 "       | 0        | 0       | 0       |
|                         | 3 "       |          |         |         |                        | 3 "       | 0        | 0       | 0       |
|                         | 4 "       |          |         |         |                        | 4 "       | 1        | 0       | 0       |
|                         | 5 "       |          |         |         |                        | 5 "       | 0        | 0       | 1       |
|                         | 6 "       |          |         |         |                        | 6 "       | 1        | 0       | 0       |
|                         | 3rd line. |          |         |         |                        | 3rd line. |          |         |         |
|                         | 1 target  | Nil.     | Nil.    | Nil.    |                        | 1 target  | 1        | 0       | 0       |
|                         | 2 "       |          |         |         |                        | 2 "       | 0        | 0       | 0       |
|                         | 3 "       |          |         |         |                        | 3 "       | 0        | 0       | 0       |
|                         | 4 "       |          |         |         |                        | 4 "       | 0        | 0       | 0       |
|                         | 5 "       |          |         |         |                        | 5 "       | 0        | 0       | 0       |
|                         | 6 "       |          |         |         |                        | 6 "       | 0        | 0       | 0       |
| Struck 142 yards short. | 1st line. |          |         |         | Struck 30 yards short. | 1st line. |          |         |         |
|                         | 1 target  | Nil.     | Nil.    | Nil.    |                        | 1 target  | 7        | 5       | 6       |
|                         | 2 "       |          |         |         |                        | 2 "       | 30       | 4       | 9       |
|                         | 3 "       |          |         |         |                        | 3 "       | 8        | 1       | 1       |
|                         | 4 "       |          |         |         |                        | 4 "       | 0        | 1       | 0       |
|                         | 5 "       |          |         |         |                        | 5 "       | 0        | 0       | 0       |
|                         | 6 "       |          |         |         |                        | 6 "       | 0        | 0       | 0       |
|                         | 2nd line. |          |         |         |                        | 2nd line. |          |         |         |
|                         | 1 target  | Nil.     | Nil.    | Nil.    |                        | 1 target  | 11       | 1       | 1       |
|                         | 2 "       |          |         |         |                        | 2 "       | 5        | 4       | 3       |
|                         | 3 "       |          |         |         |                        | 3 "       | 7        | 7       | 3       |
|                         | 4 "       |          |         |         |                        | 4 "       | 2        | 1       | 3       |
|                         | 5 "       |          |         |         |                        | 5 "       | 0        | 0       | 1       |
|                         | 6 "       |          |         |         |                        | 6 "       | 0        | 0       | 0       |
|                         | 3rd line. |          |         |         |                        | 3rd line. |          |         |         |
|                         | 1 target  | Nil.     | Nil.    | Nil.    |                        | 1 target  | 0        | 2       | 2       |
|                         | 2 "       |          |         |         |                        | 2 "       | 0        | 1       | 2       |
|                         | 3 "       |          |         |         |                        | 3 "       | 0        | 1       | 4       |
|                         | 4 "       |          |         |         |                        | 4 "       | 0        | 1       | 1       |
|                         | 5 "       |          |         |         |                        | 5 "       | 0        | 0       | 1       |
|                         | 6 "       |          |         |         |                        | 6 "       | 0        | 0       | 0       |
| Struck 111 yards short. | 1st line. |          |         |         | Struck 82 yards short. | 1st line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                        | 1 target  | Nil.     | Nil.    | Nil.    |
|                         | 2 "       | 0        | 0       | 1       |                        | 2 "       |          |         |         |
|                         | 3 "       | 0        | 0       | 0       |                        | 3 "       |          |         |         |
|                         | 4 "       | 0        | 0       | 0       |                        | 4 "       |          |         |         |
|                         | 5 "       | 0        | 0       | 0       |                        | 5 "       |          |         |         |
|                         | 6 "       | 2        | 0       | 1       |                        | 6 "       |          |         |         |
|                         | 2nd line. |          |         |         |                        | 2nd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 0       |                        | 1 target  | Nil.     | Nil.    | Nil.    |
|                         | 2 "       | 0        | 0       | 0       |                        | 2 "       |          |         |         |
|                         | 3 "       | 0        | 0       | 0       |                        | 3 "       |          |         |         |
|                         | 4 "       | 0        | 0       | 0       |                        | 4 "       |          |         |         |
|                         | 5 "       | 0        | 0       | 0       |                        | 5 "       |          |         |         |
|                         | 6 "       | 0        | 0       | 1       |                        | 6 "       |          |         |         |
|                         | 3rd line. |          |         |         |                        | 3rd line. |          |         |         |
|                         | 1 target  | 0        | 0       | 1       |                        | 1 target  | Nil.     | Nil.    | Nil.    |
|                         | 2 "       | 0        | 0       | 0       |                        | 2 "       |          |         |         |
|                         | 3 "       | 0        | 0       | 0       |                        | 3 "       |          |         |         |
|                         | 4 "       | 0        | 0       | 1       |                        | 4 "       |          |         |         |
|                         | 5 "       | 0        | 0       | 0       |                        | 5 "       |          |         |         |
|                         | 6 "       | 0        | 0       | 0       |                        | 6 "       |          |         |         |



SIR, O.S. Committee, 7th February 1865.

WITH reference to your letter dated 22/12/64, and subsequent instructions received from the President of the Ordnance Select Committee, I have the honour to submit the accompanying abstracts for the information of the Special Committee on Armstrong and Whitworth Guns.

1. These abstracts show the results of experiments made to determine the initial and remaining velocities of various projectiles fired with different charges from the competitive Armstrong and Whitworth 70-pounder guns.

2. The experiments took place at Shoeburyness on the 2nd, 3rd, 4th, 5th, and 6th of January 1865, and were carried out by means of Navez's electro-ballistic apparatus.

Two of these instruments were simultaneously employed in the investigations, and the velocity of each shot was observed at two points in the trajectory, one near the muzzle of the gun, the other at some distance from it. The practice was continued until five good observations were obtained with each charge and nature of projectile; and the mean loss of velocity which the shot experienced in passing over the space included between the two points was thus ascertained.

3. All the guns were charged and fired under the same circumstances, and a table (VII.) has been prepared giving the actual atmospherical state on each day during the experiments.

4. The projectiles used were solid shot, shrapnel or segment shell, and common shell. The shells were weighted up with sand and plugged.

5. The velocities of the projectiles were observed at the respective distances of 40 and 500 yards from the muzzle.

6. All the guns used lubricating wads throughout, except during a special experiment made to ascertain the effect of firing the breech-loading Armstrong 70-pounder without lubricators.

7. The Armstrong guns used the ordinary cartridge made up with serge bag. A special cartridge was used with the Whitworth gun.

This gun was vented in rear in prolongation of the axis of the bore; and the cartridge was made up in serge, and was provided with a paper tube containing quick match, which was inserted in the middle of the cartridge, so as to conduct the flame from the friction tube to near the centre of the mass of powder constituting the charge. The length of the paper tube was about 6·8 inches, the Whitworth cartridges were therefore ignited at a point 6·8 inches from the bottom of the bore.

The flame from the friction tube ignited the Armstrong cartridges through the vent in the following manner:—

70-pounder muzzle loader, 6·5 inches from end of bore.  
70-pounder breech loader, 4·5 inches from end of bore.

8. Table I. gives the mean results of the whole experiment.

Table II. gives the comparative mean results of the muzzle-loading guns, deduced from Table I.

From this table it appears that the initial velocities of the Armstrong solid shot with 12 and 10 lbs. are respectively 1,500 and 1,336 feet, while with the same charges the Whitworth shot are 1,395 and 1,338 feet.

With a charge of 12 lbs., therefore, the initial velocity of the Armstrong shot exceeds that of the Whitworth by 105 feet, and with a charge of 10 lbs. the Whitworth exceeds the Armstrong by 2 feet.

The initial velocities of the other projectiles are in much the same ratio, that is to say, the Armstrong gun is the best with 12 lbs., and the Whitworth with 10 lbs. This

seems to indicate that 12 lbs. is more powder than the Whitworth 70-pounder can burn with advantage.

And from Table I. it will be seen that 14 lbs. is more powder than the Armstrong 70-pounder can use with advantage.

The use of a tube in the Whitworth cartridge has contributed greatly to the favourable results which have been obtained. Indeed, this form of cartridge probably gives a greater velocity than the plan of venting the gun so as to strike the cartridge in the centre.

In an experiment carried out with a 70-pounder Whitworth gun for the Ordnance Select Committee in 1862, the initial velocity of a shot of 69 lbs., with charge 10 lbs., was 1,204 feet, where the cartridge was ignited close to the rear.

Igniting in the centre has therefore increased the velocity by more than 100 feet.

This method of igniting the cartridge in the centre by means of a tube communicating with the rear, appears to have originated with the late Captain Lyons, R.A., while Inspector of Artillery.

His experiments were carried out at the Proof Butt, Woolwich, in connexion with the proof of ordnance, and are detailed by him in a report to the Ordnance Select Committee, dated 13/5/62, Minute 6584, 61/I. of Art./241.

9. As might be expected from its smaller sectional area, the Whitworth shot experiences a less resistance than the Armstrong.

Thus the loss experienced by the Armstrong solid shot with 10 lbs. charge, in passing over 460 yards of air, was 128 feet, while under the same circumstances the Whitworth shot lost 86 feet, showing a difference in favour of the latter of 42 feet.

The other projectiles are in much the same ratio, that is to say, the Whitworth projectiles invariably lose less velocity than the corresponding Armstrong projectiles, although the actual amount of difference varies according to the velocity, weight, and shape of the projectile.

Thus with the Armstrong muzzle-loading projectiles, the common and segment shells lose slightly less velocity than the solid shot with the lowest charge, probably owing to some difference in their form of head.

10. It appears that when the breech-loading Armstrong gun is fired without lubricating wads, there is a slight diminution in the velocity of the projectile; thus, the initial velocity of the solid shot from this gun is 1,163 when lubricating wads are used, and 1,137 without these wads.

11. The powder used in this practice with all the 70-pounder guns was slightly weaker than that employed with the 12-pounder guns in the experiments alluded to in my report 11/6/64.

This is shown by the velocity given by the standard Armstrong 12-pounder, Table VI. The initial velocity here given is 1,199 feet, while in the case of the 12-pounder experiments it was 1,238·8 feet. This slight difference in strength is constantly met with in practice with different lots of A 4 powder.

12. Tables III., IV., V., and VI. give the separate results of each shot, with a description of the several guns employed.

Table VII. gives the atmospherical state during the practice.

I have, &c.

WM. H. NOBLE, Lieut. R.A.,  
Associate Member,  
O.S. Committee.

Major Dyer, R.A.,  
Sec., Special Committee,  
Armstrong and Whitworth Guns.

TABLE I.

TABLE showing the Mean Observed Velocities of Projectiles fired with different Charges from the Armstrong and Whitworth Competitive 70-pr. Guns.

| No. of Rounds. | Nature of Gun.          | Charge. | Projectile.                |              |                  | Proportion between Weight of Projectile and Weight of Charge. | Mean Observed Velocities. |                 |                    | Calculated Mean Initial Velocity. |
|----------------|-------------------------|---------|----------------------------|--------------|------------------|---------------------------------------------------------------|---------------------------|-----------------|--------------------|-----------------------------------|
|                |                         |         | Nature.                    | Weight. lbs. | Diameter. ins.   |                                                               | At 40 Yards.              | At 500 Yards.   | Lost in 460 Yards. |                                   |
| 5              | 70-pr., M.L. Armstrong. | 14      | Hollow-headed Shot.        | 71.25        | 6.34             | 0.1965                                                        | feet.<br>1524.8           | feet.<br>1367.4 | feet.<br>157.4     | 1539.0*                           |
| "              | "                       | 12      | "                          | "            | "                | 0.1684                                                        | 1486.6                    | 1336.9          | 149.7              | 1500.0                            |
| "              | "                       | 10      | "                          | "            | "                | 0.1403                                                        | 1325.2                    | 1197.2          | 128.0              | 1336.0                            |
| "              | 70-pr., B.L. Armstrong. | 9       | "                          | 70.81        | 6.44             | 0.1271                                                        | 1154.8                    | 1068.2          | 86.6               | 1163.0                            |
| "              | 70-pr., M.L. Whitworth. | 12      | Solid Shot -               | 70.09        | { 5.46<br>4.98 } | 0.1712                                                        | 1386.1                    | 1292.4          | 93.7               | 1395.0                            |
| "              | "                       | 10      | "                          | "            | "                | 0.1427                                                        | 1329.5                    | 1243.2          | 86.3               | 1338.0                            |
| "              | 70-pr., M.L. Armstrong. | 14      | Shrapnel or Segment Shell. | 69.20        | 6.34             | 0.2023                                                        | 1576.1                    | 1416.1          | 160.0              | 1591.0                            |
| "              | "                       | 12      | "                          | "            | "                | 0.1734                                                        | 1496.7                    | 1346.4          | 150.3              | 1510.0                            |
| "              | "                       | 10      | "                          | "            | "                | 0.1445                                                        | 1349.0                    | 1227.5          | 121.5              | 1360.0                            |
| "              | 70-pr., B.L. Armstrong. | 9       | "                          | 76.64        | 6.44             | 0.1174                                                        | 1091.5                    | 1015.3          | 76.2               | 1098.0                            |
| "              | 70-pr., M.L. Whitworth. | 12      | "                          | 67.84        | { 5.46<br>4.98 } | 0.1769                                                        | 1417.4                    | 1315.4          | 102.0              | 1427.0                            |
| "              | "                       | 10      | "                          | "            | "                | 0.1474                                                        | 1370.9                    | 1274.9          | 96.0               | 1380.0                            |
| "              | 70-pr., M.L. Armstrong. | 10      | Common Shell.              | 70.30        | 6.34             | 0.1422                                                        | 1323.8                    | 1206.5          | 117.3              | 1334.0                            |
| "              | 70-pr., B.L. Armstrong. | 9       | "                          | 69.80        | 6.44             | 0.1289                                                        | 1166.9                    | 1080.9          | 86.0               | 1175.0                            |
| "              | 70-pr., M.L. Whitworth. | 12      | "                          | 70.30        | { 5.46<br>4.98 } | 0.1707                                                        | 1375.0                    | 1283.0          | 92.0               | 1384.0                            |
| "              | "                       | 10      | "                          | "            | "                | 0.1422                                                        | 1332.7                    | 1244.4          | 88.3               | 1341.0                            |
| 3              | 70-pr., B.L. Armstrong. | 9       | Hollow-headed Shot.        | 70.81        | 6.44             | 0.1271                                                        | 1129.3                    | —               | —                  | 1137.0                            |
| "              | "                       | "       | Seg. Shell.                | 76.64        | "                | 0.1174                                                        | 1073.4                    | —               | —                  | 1080.0                            |
| "              | "                       | "       | Com. Shell.                | 69.80        | "                | 0.1289                                                        | 1146.0                    | —               | —                  | 1154.0                            |

\* Lubricating wads used throughout.

† Fired without lubricating wads.

TABLE II.

TABLE showing the Comparative Gain and Loss in Velocity of Projectiles fired from the 70-pr. M.L. Armstrong and Whitworth Guns, the 70-pr. Armstrong being taken as the Standard.

| Nature of Gun.     | Charge. lbs. | Nature of Projectile.        | Initial Velocity. |                |            | Observed Loss of Velocity in 460 Yards. |               |            |
|--------------------|--------------|------------------------------|-------------------|----------------|------------|-----------------------------------------|---------------|------------|
|                    |              |                              | Rate per Second.  | Increase.      | Decrease.  | Amount.                                 | Increase.     | Decrease.  |
| 70-pr., Armstrong. | 14           | Shot.                        | feet.<br>1500.0   | feet.<br>105.0 | feet.<br>— | feet.<br>149.7                          | feet.<br>56.0 | feet.<br>— |
| 70-pr., Whitworth. | 12           | "                            | 1395.0            | —              | 105.0      | 93.7                                    | —             | 56.0       |
| 70-pr., Armstrong. | 10           | "                            | 1336.0            | —              | 2.0        | 128.0                                   | 41.7          | —          |
| 70-pr., Whitworth. | 10           | "                            | 1338.0            | 2.0            | —          | 86.3                                    | —             | 41.7       |
| 70-pr., Armstrong. | 14           | * Shrapnel or Segment Shell. | 1510.0            | 83.0           | —          | 150.3                                   | 48.3          | —          |
| 70-pr., Whitworth. | 12           | "                            | 1427.0            | —              | 83.0       | 102.0                                   | —             | 48.3       |
| 70-pr., Armstrong. | 10           | "                            | 1360.0            | —              | 20.0       | 121.5                                   | 25.5          | —          |
| 70-pr., Whitworth. | 10           | "                            | 1380.0            | 20.0           | —          | 96.0                                    | —             | 25.5       |
| 70-pr., Armstrong. | 10           | Common Shell.                | 1334.0            | —              | 7.0        | 117.3                                   | 29.0          | —          |
| 70-pr., Whitworth. | 10           | "                            | 1341.0            | 7.0            | —          | 88.3                                    | —             | 29.0       |

\* The Whitworth gun fired shrapnel shell ; the Armstrong guns segment shell.

TABLE III.

TABLE showing the total Number of Rounds fired for Velocity and Retardation, Armstrong and Whitworth Competitive 70-pr. Guns.

70-pr. M.L. Armstrong Gun "A."

Total length - 123.25 inches.  
Diameter of bore 6.4 "  
Length of bore - 108.0 "

Brand of Powder, A 4, 16 $\frac{1}{4}$ , Lot 706.

Grooves { Number - 3.  
Width - { 0.7 in rear of shunt.  
              { in front of shunt.  
Depth - { 0.106 loading.  
              { 0.007 driving.

Spiral -

| Date of Experiment. | Charge. |                      |                        | Projectile.                                  |         |           | Distance at which Velocity was observed. | Observed Velocities. |        |        |        |        | Mean observed Velocity. | Mean Loss in 460 Yards. |
|---------------------|---------|----------------------|------------------------|----------------------------------------------|---------|-----------|------------------------------------------|----------------------|--------|--------|--------|--------|-------------------------|-------------------------|
|                     | Weight. | Length of Cartridge. | Diameter of Cartridge. | Nature.                                      | Weight. | Diameter. |                                          | 1                    | 2      | 3      | 4      | 5      |                         |                         |
| 2.1.65              | 14      | 16.00*               | 5.50                   | Hollow-headed Shot.                          | 71.250  | 6.34      | 40                                       | 1522.9               | 1515.3 | 1529.1 | 1527.5 | 1529.1 | 1524.8                  | 157.4†                  |
| "                   | "       | "                    | "                      | "                                            | "       | "         | 500                                      | 1366.1               | 1353.2 | 1367.7 | 1374.9 | 1374.9 | 1367.4                  |                         |
| "                   | 12      | 13.00                | 5.75                   | "                                            | "       | "         | 40                                       | 1479.9               | 1474.2 | 1505.3 | 1480.1 | 1493.6 | 1486.6                  | 149.7                   |
| "                   | "       | "                    | "                      | "                                            | "       | "         | 500                                      | 1335.1               | 1316.7 | 1352.4 | 1327.4 | 1352.8 | 1336.9                  |                         |
| "                   | 10      | 12.50                | 5.25                   | "                                            | "       | "         | 40                                       | 1323.9               | 1330.0 | 1322.7 | 1317.9 | 1331.3 | 1325.2                  | 128.0                   |
| "                   | "       | "                    | "                      | "                                            | "       | "         | 500                                      | 1191.9               | 1205.9 | 1193.2 | 1192.7 | 1202.1 | 1197.2                  |                         |
| 3.1.65              | 14      | 14.75                | 5.75                   | Segment Shell, weighted with sand & plugged. | 69.207  | "         | 40                                       | 1575.7               | 1575.7 | 1569.2 | 1577.4 | 1582.3 | 1576.1                  | 155.0                   |
| "                   | "       | "                    | "                      | "                                            | "       | "         | 500                                      | 1412.1               | 1401.8 | 1398.5 | 1440.2 | 1427.8 | 1416.1                  |                         |
| 2.1.65              | 12      | 13.00                | 5.75                   | "                                            | "       | "         | 40                                       | 1497.1               | 1516.8 | 1510.7 | 1483.8 | 1475.1 | 1496.7                  | 150.3                   |
| "                   | "       | "                    | "                      | "                                            | "       | "         | 500                                      | 1341.4               | 1362.5 | 1357.7 | 1336.7 | 1333.5 | 1346.4                  |                         |
| 3.1.65              | 10      | 12.50                | 5.25                   | "                                            | "       | "         | 40                                       | 1357.3               | 1349.7 | 1339.8 | 1346.0 | 1352.3 | 1349.0                  | 121.5                   |
| "                   | "       | "                    | "                      | "                                            | "       | "         | 500                                      | 1237.4               | 1226.7 | 1217.5 | 1221.4 | 1234.7 | 1227.5                  |                         |
| "                   | "       | "                    | "                      | Common Shell, weighted with sand & plugged.  | 70.300  | "         | 40                                       | 1320.1               | 1335.8 | 1315.4 | —      | —      | 1323.8                  | 117.3                   |
| "                   | "       | "                    | "                      | "                                            | "       | "         | 500                                      | 1203.0               | 1215.9 | 1200.4 | —      | —      | 1206.5                  |                         |

\* These 14 lb. cartridges were not so well made as those used with the segment shell.

† Lubricating wads used throughout.

TABLE IV.

TABLE showing the total Number of Rounds fired for Velocity and Retardation, Armstrong and Whitworth Competitive 70-pr. Guns.

70-pr. B.L. Armstrong.

Total length - 109.95 inches.  
Diameter of bore 6.4 "  
Length of bore - 91.92 "

Brand of Powder, A 4, 16 $\frac{1}{4}$ , Lot 706.

Grooves { Number - 70.  
Width - { 0.166 inches.  
Depth - { 0.06 "

Spiral - 1 turn in 288 inches.

| Date of Experiment. | Charge. |                      |                        | Projectile.                                  |         |           | Distance at which Velocity was observed. | Observed Velocities. |        |        |        |        | Mean observed Velocity. | Mean Velocity lost in 460 Yards. |
|---------------------|---------|----------------------|------------------------|----------------------------------------------|---------|-----------|------------------------------------------|----------------------|--------|--------|--------|--------|-------------------------|----------------------------------|
|                     | Weight. | Length of Cartridge. | Diameter of Cartridge. | Nature.                                      | Weight. | Diameter. |                                          | 1                    | 2      | 3      | 4      | 5      |                         |                                  |
| 6.1.65              | 9       | 12.75                | 5.0                    | Hollow-headed Shot.                          | 70.812  | 6.44      | 40                                       | 1161.4               | 1139.1 | 1149.7 | 1171.2 | 1152.6 | 1154.8                  | 86.6                             |
| "                   | "       | "                    | "                      | "                                            | "       | "         | 500                                      | 1068.9               | 1053.6 | 1063.8 | 1091.0 | 1063.8 | 1068.2                  |                                  |
| "                   | "       | "                    | "                      | Segment Shell, weighted with sand & plugged. | 76.644  | "         | 40                                       | 1071.3               | 1091.1 | 1100.2 | 1007.6 | 1087.4 | 1091.5                  | 72.6                             |
| "                   | "       | "                    | "                      | "                                            | "       | "         | 500                                      | 993.0                | 1014.6 | 1027.9 | 1031.9 | 1009.2 | 1015.3                  |                                  |
| "                   | "       | "                    | "                      | Common Shell, weighted with sand & plugged.  | 69.801  | "         | 40                                       | 1160.4               | 1166.3 | 1164.3 | 1167.3 | 1176.2 | 1166.9                  | 86.0                             |
| "                   | "       | "                    | "                      | "                                            | "       | "         | 500                                      | 1071.0               | 1081.5 | 1080.4 | 1081.5 | 1090.0 | 1080.9                  |                                  |
| "                   | "       | "                    | "                      | Solid Shot.                                  | 70.812  | "         | 40                                       | 1113.3               | 1137.3 | 1136.3 | —      | —      | 1129.3                  | —                                |
| "                   | "       | "                    | "                      | Segment Shell.                               | 76.644  | "         | 40                                       | 1071.6               | 1073.4 | 1075.2 | —      | —      | 1073.4                  | —†                               |
| "                   | "       | "                    | "                      | Common Shell.                                | 69.801  | "         | 40                                       | 1148.6               | 1143.7 | 1145.6 | —      | —      | 1146.0                  | —                                |

\* Lubricating wads used.

† Fired without lubricating wads.



TABLE V.

TABLE showing the total Number of Rounds fired for Velocity and Retardation, Armstrong and Whitworth Competitive 70-pr. Guns.

70-pr. M.L. Whitworth Gun "A."

Total length - 118·4 inches.  
Diameter of bore { major 5·53.  
minor 5·035.  
Length of bore - 108·0.

Brand of Powder, A 4, 16 $\frac{1}{4}$ , Lot 706.  
Grooves { Number - 6 hexagonal.  
Width - 2·05 inches.  
Depth - 0·247 "  
Spiral - 1 turn in about 100 inches.

| Date of Experiment. | Charge. |                      |                        | Projectile.                                   |         |              | Distance at which Velocity was observed. | Observed Velocities. |        |        |        |        | Mean observed Velocity. | Mean Velocity lost in 460 Yards. |
|---------------------|---------|----------------------|------------------------|-----------------------------------------------|---------|--------------|------------------------------------------|----------------------|--------|--------|--------|--------|-------------------------|----------------------------------|
|                     | Weight. | Length of Cartridge. | Diameter of Cartridge. | Nature.                                       | Weight. | Diameter.    |                                          | 1                    | 2      | 3      | 4      | 5      |                         |                                  |
|                     | lbs.    | ins.                 | ins.                   |                                               | lbs.    | ins.         | yds.                                     | feet.                | feet.  | feet.  | feet.  | feet.  | feet.                   | feet.                            |
| 4.1.65              | 12      | 18·0                 | 4·75                   | Solid Shot.                                   | 70·094  | 5·46<br>4·98 | 40                                       | 1395·8               | 1374·5 | 1389·1 | 1387·7 | 1383·7 | 1386·1                  | 93·7*                            |
| "                   | "       | "                    | "                      | "                                             | "       | "            | 500                                      | 1302·0               | 1280·9 | 1293·5 | 1293·5 | 1292·2 | 1292·4                  |                                  |
| "                   | 10      | 15·0                 | 5·00                   | "                                             | "       | "            | 40                                       | 1335·0               | 1325·1 | 1335·0 | 1322·6 | 1330·1 | 1329·5                  |                                  |
| "                   | "       | "                    | "                      | "                                             | "       | "            | 500                                      | 1248·0               | 1238·7 | 1249·4 | 1237·4 | 1242·7 | 1243·2                  | 86·3                             |
| 4.1.65              | 12      | 18·0                 | 4·75                   | Shrapnel Shell, weighted with sand & plugged. | 67·844  | "            | 40                                       | 1416·1               | 1422·9 | 1406·5 | 1422·9 | 1418·8 | 1417·4                  | 102·0                            |
| "                   | "       | "                    | "                      | "                                             | "       | "            | 500                                      | 1315·4               | 1318·4 | 1305·0 | 1322·9 | 1315·4 | 1315·4                  |                                  |
| "                   | 10      | 15·0                 | 5·00                   | "                                             | "       | "            | 40                                       | 1373·2               | 1386·4 | 1353·8 | 1370·6 | 1370·6 | 1370·9                  |                                  |
| "                   | "       | "                    | "                      | "                                             | "       | "            | 500                                      | 1275·1               | 1283·7 | 1264·0 | 1276·6 | 1275·1 | 1274·9                  | 96·0                             |
| 5.1.65              | 12      | 18·0                 | 4·75                   | Common Shell, weighted with sand & plugged.   | 70·300  | "            | 40                                       | 1365·8               | 1378·6 | 1385·1 | 1378·6 | 1367·0 | 1375·0                  | 92·0                             |
| "                   | "       | "                    | "                      | "                                             | "       | "            | 500                                      | 1268·8               | 1295·9 | 1295·9 | 1283·0 | 1271·6 | 1283·0                  |                                  |
| "                   | 10      | 15·0                 | 5·00                   | "                                             | "       | "            | 40                                       | 1342·1               | 1328·2 | 1327·0 | 1333·2 | 1333·2 | 1332·7                  |                                  |
| "                   | "       | "                    | "                      | "                                             | "       | "            | 50                                       | 1253·9               | 1241·7 | 1239·1 | 1244·4 | 1243·1 | 1244·4                  | 88·3                             |

\* Lubricating wads used throughout. The gun was fired through a vent in rear, in prolongation of the axis of the bore. The cartridge was ignited in the centre by means of a paper tube containing quick match, which was inserted in the cartridge, and communicated with the vent.

TABLE VI.

TABLE showing the Velocities of Segment Shells fired from the 12-pounder Armstrong Field Gun No. 8 (Standard Gun), to test the Strength of the Powder used in Experiments with the 70-pounder Competitive Armstrong and Whitworth Guns on the 2nd, 3rd, 4th, 5th, and 6th January 1865.

Weight of shell - 11·75 lbs.  
Diameter of shell - 3·07 at back end.  
Charge - 1·50 lbs.

Date of experiment - 5.1.65. Brand of Powder - A 4, 16 $\frac{1}{4}$ , Lot 706.

| Round. | Observed Velocity at 40 Yards. | Mean observed Velocity. | Calculated mean initial Velocity. | Remarks.                     |
|--------|--------------------------------|-------------------------|-----------------------------------|------------------------------|
|        | feet.                          | feet.                   | feet.                             |                              |
| 1      | 1184·5                         | 1186·3                  | 1199·0                            | Lubricators used throughout. |
| 2      | 1195·7                         |                         |                                   |                              |
| 3      | 1185·5                         |                         |                                   |                              |
| 4      | 1175·4                         |                         |                                   |                              |
| 5      | 1190·6                         |                         |                                   |                              |

TABLE VII.

TABLE showing the Density of the Air on each Day of Experiment with Navez's Apparatus during the Trial of the 70-pounder Competitive Armstrong and Whitworth Guns, the weight of one cubic foot of dry air at a temperature of 32° Fahr. and pressure of 30 inches = 563 grains, being taken as the unit.

| Date.  | Barometer observed at 10 a.m. |              | Barometer corrected. | Thermometer observed. |          | Relative Humidity. | Weight of One Cubic Foot of Air. | Relative Proportion to Standard. | Remarks.                 |
|--------|-------------------------------|--------------|----------------------|-----------------------|----------|--------------------|----------------------------------|----------------------------------|--------------------------|
|        | Height.                       | Temperature. |                      | Dry.                  | Wet.     |                    |                                  |                                  |                          |
|        | inches.                       | degrees.     | inches.              | degrees.              | degrees. |                    | grains.                          |                                  |                          |
| 2.1.65 | 29·35                         | 36           | 29·30                | 32                    | 30       | 0·802              | 549·8                            | 1·029                            | Wind :—<br>S.W.—2—clear. |
| 3.1.65 | 29·50                         | 38           | 29·48                | 36                    | 35       | 0·915              | 547·2                            | 1·024                            | N.—1—hazy.               |
| 4.1.65 | 29·80                         | 42           | 29·76                | 42                    | 40       | 0·858              | 545·5                            | 1·021                            | W.—3—hazy.               |
| 5.1.65 | 30·10                         | 45           | 30·06                | 41                    | 40       | 0·928              | 552·0                            | 1·033                            | N.W.—3—hazy.             |
| 6.1.65 | 29·90                         | 44           | 29·86                | 40                    | 38       | 0·858              | 549·6                            | 1·029                            | N.W.—4—hazy.             |

Standard weight of one cubic foot of air at 60° Fahr. and pressure of 30 inches, saturation being 0·5 = 534·3 gra.

Ordnance Select Committee,  
Royal Arsenal, Woolwich, S.E.,  
8th March 1865.

Sir,

With reference to my letter, dated 11th February 1865, and your minute thereon, I have the honour to enclose the accompanying abstracts for the information of the Special Committee on Armstrong and Whitworth Guns.

These abstracts show the results of experiments to determine the velocity of shot fired from the 70-pr. competitive guns with different brands of powder, viz., L. G. and rifle L. G. (A 4), and further to ascertain what effect the centre igniting

tube, in the Whitworth cartridge, has on the velocity of the projectile.

It appears that the use of L. G. powder is attended by a diminution in velocity in all cases except with the 70-pr. B. L. Armstrong gun, and that firing the Whitworth cartridge, without tube, through the rear vent has the effect of reducing the initial velocity by about 100 feet.

I have, &c.

(Signed) WM. H. NOBLE, Lieut. R.A.,  
The Secretary, Special Committee, Associate Member,  
Armstrong and Whitworth Guns. O.S. Committee.

TABLE showing the INITIAL VELOCITY of ELONGATED SHOT fired from the 70-PR. COMPETITIVE ARMSTRONG and WHITWORTH GUNS with different Brands of Powder and under various circumstances.

| Gun.                        | No. of Rounds. | Weight of Charge. | Weight of Projectile. | Brand of Powder. | Initial Velocity. | Remarks.             |
|-----------------------------|----------------|-------------------|-----------------------|------------------|-------------------|----------------------|
|                             |                | lbs.              | lbs.                  |                  | Ft.               |                      |
| 70-pr. Whitworth - - -      | 5              | 10                | 70·09                 | Rifle* L.G. -    | 1338·0            | With centre tube.    |
| Do. - - -                   | 5              | 10                | 70·09                 | " - -            | 1220·0            | Without centre tube. |
| Do. - - -                   | 10             | 10                | 70·09                 | L.G. - -         | 1250·0            | With centre tube.    |
| Do. - - -                   | 5              | 10                | 70·09                 | " - -            | 1165·0            | Without centre tube. |
| 70-pr. M.L. Armstrong - - - | 5              | 10                | 71·25                 | Rifle L.G. -     | 1336·0            |                      |
| Do. - - -                   | 5              | 10                | 71·25                 | L.G. - -         | 1309·0            |                      |
| 70-pr. B.L. Armstrong - - - | 5              | 9                 | 70·81                 | Rifle L.G. -     | 1163·0            |                      |
| Do. - - -                   | 5              | 9                 | 70·81                 | L. G. - -        | 1171·0            |                      |
| 12-pr. Armstrong - - -      | 5              | 1·5               | 11·75                 | Rifle L. G. -    | 1200·0            |                      |
| Standard gun - - -          | 5              | 1·5               | 11·75                 | L. G. - -        | 1153·5            |                      |

\* A 4. See W.O. Circular 892.

TABLE giving the TOTAL NUMBER of ROUNDS fired from ARMSTRONG and WHITWORTH COMPETITIVE 70-PR. GUNS to test the value of different Brands of Powder, and effect of igniting the Cartridge in the Whitworth Gun by means of a centre tube.

| Gun.                        | Charge. |            |           |                               | Projectile.                          |            |           | Observed Velocities at 40 yards. |        |        |        |        | Mean observed Velocity. | Remarks.                                     |                               |
|-----------------------------|---------|------------|-----------|-------------------------------|--------------------------------------|------------|-----------|----------------------------------|--------|--------|--------|--------|-------------------------|----------------------------------------------|-------------------------------|
|                             | Weight. | Cartridge. |           | Brand of Powder.              | Nature.                              | Weight.    | Diameter. | 1.                               | 2.     | 3.     | 4.     | 5.     |                         |                                              |                               |
|                             |         | Length.    | Diameter. |                               |                                      |            |           |                                  |        |        |        |        |                         |                                              |                               |
| 70-pr. Whitworth            | lbs.    | In.        | In.       |                               |                                      | lbs.       | In.       | Ft.                              | Ft.    | Ft.    | Ft.    | Ft.    | Ft.                     |                                              |                               |
| -                           | 10      | 15·0       | 4·75      | Rifle L.G., 16/1/64, Lot 706. | Elongated solid shot.                | 70·09      | 5·46      | 1221·0                           | 1209·5 | 1214·7 | 1202·2 | 1212·6 | 1212·0                  | { Fired without a tube.<br>Do.<br>Do.<br>Do. |                               |
| Do.                         | -       | 10         | 15·0      | 4·75                          | L.G., 26/10/63, Lot 661.             | Do.        | 70·09     | 4·98                             | 1160·1 | 1172·9 | 1145·6 | 1146·6 | 1166·0                  |                                              | 1153·2                        |
| Do.                         | -       | 10         | 15·0      | 1·75                          | Do.                                  | Do.        | 70·09     | 4·98                             | 1241·3 | 1243·5 | 1224·1 | 1250·1 | 1234·4                  |                                              | { 1241·8 { Fired with a tube. |
| Do.                         | -       | 10         | 15·0      | 4·75                          | Do.                                  | Do.        | 70·09     | 4·98                             | 1244·6 | 1234·8 | 1244·6 | 1233·7 | 1237·0                  |                                              |                               |
| 70-pr. M.L. Armstrong       | 10      | 12·5       | 5·5       | Do.                           | Elongated solid shot, hollow-headed. | 71·25      | 6·34      | 1287·0                           | 1300·9 | 1308·0 | 1321·0 | 1276·8 | 1298·7                  |                                              |                               |
| 70-pr. B.L. Armstrong       | 9       | 12·5       | 5·25      | Do.                           | Do.                                  | 70·81      | 6·55      | 1153·4                           | 1164·1 | 1168·0 | 1171·0 | 1157·2 | 1162·7                  |                                              |                               |
| 12-pr. Armstrong            | -       | 1·5        | 8·50      | 2·75                          | Do.                                  | Seg. shell | 11·75     | 3·07                             | 1133·1 | 1151·9 | 1149·1 | 1136·9 | 1153·9                  | 1145·0                                       |                               |
| Standard gun in comparison. | 1·5     | 8·25       | 2·75      | Rifle L.G., 16/1/64, Lot 706. | Do.                                  | 11·75      | 3·07      | 1188·1                           | 1193·0 | 1195·0 | 1200·0 | 1175·1 | 1190·2                  |                                              |                               |





# 70 PR GUNS

## SOLID SHOT

0° by spirit level, Axis      feet above the Plane  
 Obtained from 20 Rounds, 14<sup>th</sup> Oct<sup>r</sup> 1864.

| B. L. ARMSTRONG | 36.1 Yards | 1.2 Yds | MEAN RANGES |
|-----------------|------------|---------|-------------|
|                 |            |         | 450 Yards   |

| WHITWORTH | 47.6 Yards | 1.2 Yds | 506 |
|-----------|------------|---------|-----|
|           |            |         |     |

| M. L. ARMSTRONG | 30.0 Yards | 1.2 Yds | 484 |
|-----------------|------------|---------|-----|
|                 |            |         |     |



# 70 PR GUNS

## COMMON SHELL

1° by spirit level, Axis feet above the Plane  
 Obtained from 30 Rounds, 8<sup>th</sup> Nov<sup>r</sup> 1864.

B. L. ARMSTRONG

47.8 Yards

MEAN RANGES  
715 Yards.

WHITWORTH

63.5 Yards

882

M. L. ARMSTRONG

34.4 Yards

828

Scale of 12 Yards to one Inch





# SEGMENT AND SHRAPNELL SHELL

2° by spirit level, Axis feet above the Plane  
Obtained from 31 Rounds, 11<sup>th</sup> Oct<sup>r</sup>. 1864.



Scale of 24 Yards to one Inch.



# 70 PR GUNS

## SOLID SHOT

3° by spirit level, Axis feet above the Plane  
Obtained from 30 Rounds, 12<sup>th</sup> Oct. 1864.

MEAN RANGES  
1372 Yards

54.9 Yards

2.1 Yds.

B. L. ARMSTRONG

79.7 Yards

2.2 Yds.

WHITWORTH

1761

49.3 Yards

3.6 Yds.

M. L. ARMSTRONG

1614

Scale of 12 Yards to one Inch.



# 70 PR GUNS

## COMMON SHELL

4° by spirit level, Axis      feet above the Plane  
 Obtained from 30 Rounds, 22<sup>nd</sup> Nov<sup>r</sup> 1864.

MEAN RANGES  
 1548 Yards.

3.7 Yds.

66.0 Yards

B. L. ARMSTRONG

81.3 Yards

3.4 Yds.

1987

WHITWORTH

74.4 Yards

2.5 Yds.

1805

M. L. ARMSTRONG

Scale of 12 Yards to one Inch.





# 70 P<sup>R</sup> GUNS

## SEGMENT AND SHRAPNEL SHELL.

5° by spirit level, Axis      feet above the Plane  
 Obtained from 16 Rounds, 9<sup>th</sup> Nov<sup>r</sup> 1864.



B. L. ARMSTRONG



WHITWORTH



M. L. ARMSTRONG

Scale of 24 Yards to one Inch.



# 70 PR GUNS

## SOLID SHOT

6° by spirit level, Axis feet above the Plane  
 Obtained from 40 Rounds, 25<sup>th</sup> Oct. 1864.

116.7 Yards.

B L. ARMSTRONG

MEAN RANGES  
 2266 Yards

6.9 Yds.

69.1 Yards.

WHITWORTH

2948

7.0 Yds.

68.8 Yards.

M L. ARMSTRONG

2656

6.5 Yds.

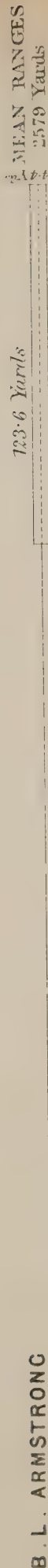
Scale of 16 Yards to one Inch.



# 70 PR GUNS

## COMMON SHELL.

7° by spirit level, Axis      feet above the Plane  
 Obtained from 34 Rounds, 21<sup>st</sup> Nov<sup>r</sup> 1864.



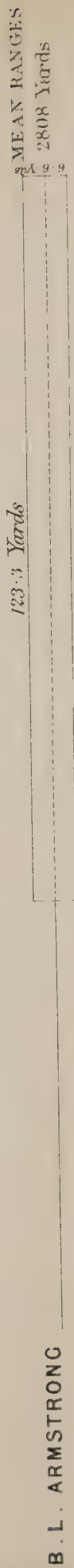
Scale of 48 Yards to one Inch.





# SEGMENT AND SHRAPNEL SHELL.

8° by spirit level, Axis feet above the Plane  
 Obtained from 20 Rounds, 13<sup>th</sup> Oct. 1864.



Scale of 24 Yards to one Inch.

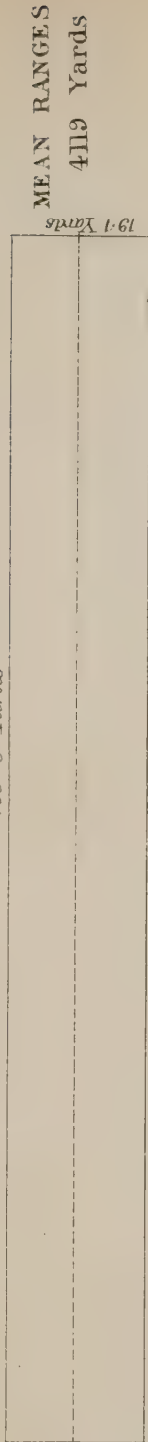


# 70 PR GUNS

## SOLID SHOT

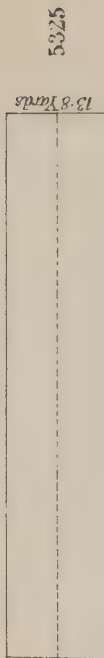
9° by spirit level, Axis      feet above the Plane  
 Obtained from 20 Rounds, 2<sup>nd</sup> March 1865

763.5 Yards



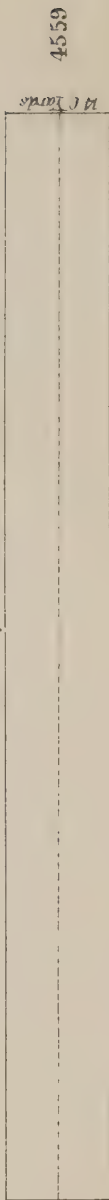
B. L. ARMSTRONG

74.1 Yards



WHITWORTH

747.5 Yards



M. L. ARMSTRONG



COMMON SHELL.

10<sup>0</sup> by spirit level, Axis feet above the Plane  
Obtained from 28 Rounds, 10<sup>th</sup> Nov<sup>r</sup> 1864



Scale of 48 Yards to one Inch.





# 70 PR GUNS

## SEGMENT AND SHRAPNELL SHELL

11° by spirit level, Axis      feet above the Plane  
 Obtained from 35 Rounds, 9<sup>th</sup> Nov<sup>r</sup> 1864.

MEAN RANGES  
 3477 Yards.

147.2 Yards

149.6

B. L. ARMSTRONG

122.3 Yards

121.6

WHITWORTH

4649

115.9 Yards

118.2

M. L. ARMSTRONG

4072

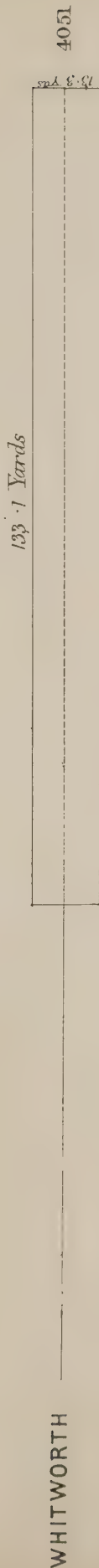


# 70 PR GUNS

## SOLID SHOT

12° by spirit level, Axis feet above the Plane

Obtained from 25 Rounds, 26<sup>th</sup> Oct. 1864



Scale of 24 Yards to one Inch



# 70 PR GUNS

## SOLID SHOT

15 elevating by spirit, Axis feet above the Plane  
 Obtained from 21 Rounds, June 21<sup>st</sup> 1865.

125.5 Yards

| MEAN | RANGES |
|------|--------|
| 4728 | Yards  |

B. L. ARMSTRONG

66.2 Yards

|      |
|------|
| 6252 |
|------|

WHITWORTH

178.8 Yards

|      |
|------|
| 5291 |
|------|

M. L. ARMSTRONG



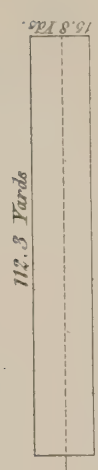


# 70 PR GUNS

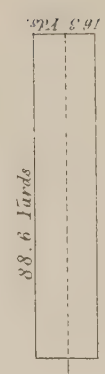
## COMMON SHELL

17° by spirit level, Axis feet above the Plane  
 Obtained from 18 Rounds, 21<sup>st</sup> Nov<sup>r</sup> 1864.

MEAN RANGES  
 5040 Yards.

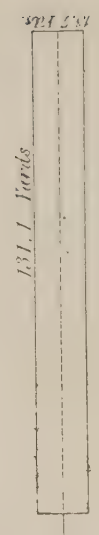


B. L. ARMSTRONG



WHITWORTH

6740



M. L. ARMSTRONG

5550

Scale of 48 Yards to one Inch.



# 70 PR GUNS

## SECMENT AND SHRAPNELL SHELL

19° by spirit level, Axis feet above the Plane  
 Obtained from 16 Rounds, 18 Nov. 1864.

B. L. ARMSTRONG

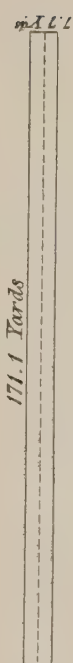
201.3 Yards



MEAN RANGES  
 5368 Yards.

WHITWORTH

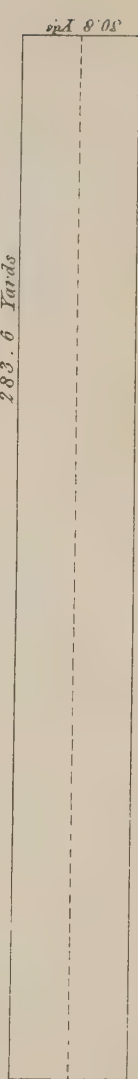
171.1 Yards



7718

M. L. ARMSTRONG

283.6 Yards



6605



# 70 PR GUNS

## SOLID SHOT

21° by spirit level , Axis      feet above the Plane.  
 Obtained from 18 Rounds, 22<sup>nd</sup> Nov<sup>r</sup> 1864

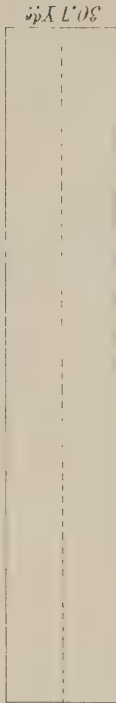
344. 2 Yards



MEAN RANGES  
 5821 Yards

B. L. ARMSTRONG

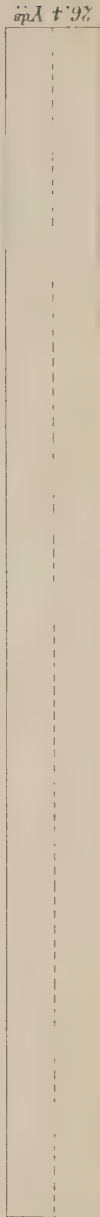
183. 8 Yards



7965

WHITWORTH

324. 5 Yards



6330

M. L. ARMSTRONG



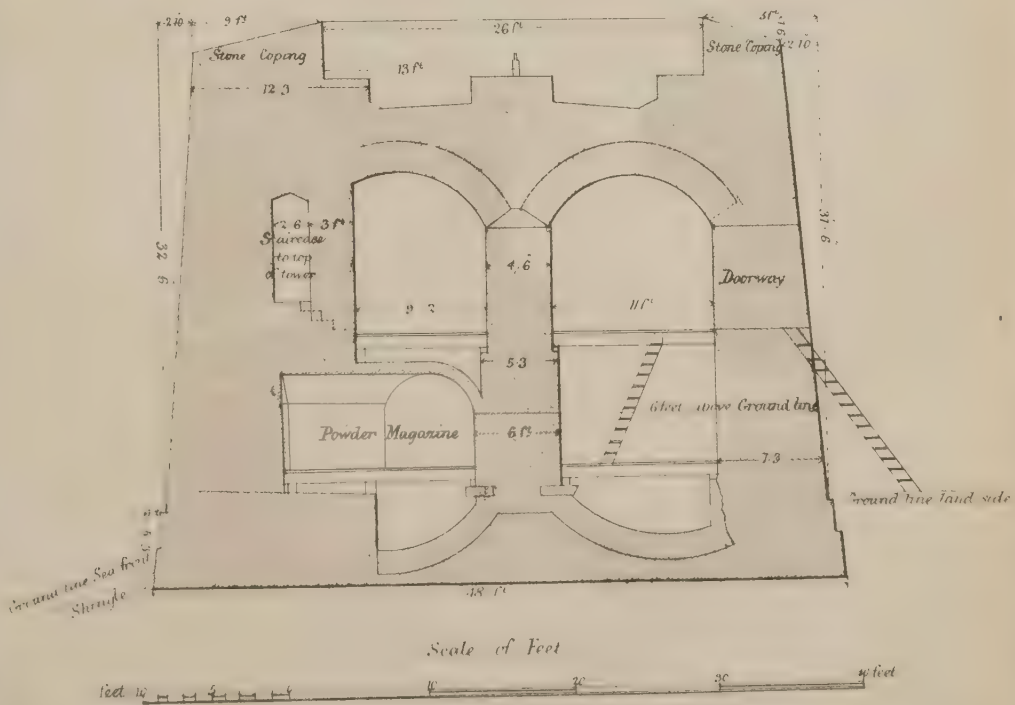


Nº 48 TOWER BEXHILL

Plan of the Top of the Tower



### Elevational Section on the Line A B





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N.B.—The Numbers inserted after the word *App.* indicate the page to which reference is made, while the other Numbers refer to the questions in the evidence.

## INDEX TO 12-PR. EXPERIMENTS.

### A.

#### ACCIDENTS:

Evidence of several witnesses to accidents with vent-pieces in Armstrong guns, when of the old pattern, or without the projecting strengthened back; *Cox, S.* 251. 255. 342; *Cox, J.* 433. 450-466; *Liddell* 986. 995; *Bechervaise* 1224-1244; *Milward* 1359; *Harrison, A.* 1426; *Taylor* 1555; *Hewlett* 2134; *Powell* 2228; *Anderson* 2514. 2529; *Gardner* 2640. 2659. Injury to eight men in H.M.S. "Harrier's," pinnace off New Zealand, by vent-piece of 12-pr. Armstrong; *Seymour*, 1995. Bursting of 150-pr. Armstrong gun; *Taylor* 1555. Bursting of Whitworth guns; *Gordon* 1760; *Hewlett* 2051. 2068-2076; *Noble* 3468-3471; *Whitworth* 3876-3891. Accident in the "Stork" gun-boat by the explosion of shell; *Liddell* 1019. Pillar fuze liable to cause accidents; *Boxer* 1725; *Bent* 2759. Explosion of a pillar fuze in store department, Woolwich; *Gordon* 1812.

#### ACCURACY:

Evidence of the great accuracy of the Armstrong gun; *Cox, S.* 231; *Cox, J.* 415; *Alderson* 580; *Milman* 763; *Liddell* 947; *Bechervaise* 1201; *Milward* 1331; *Boxer* 1621; *Rice* 1904; *Hewlett* 2049; *Powell* 2269; *Gardner* 2603. Accuracy comparatively unimportant for naval ordnance; *Rice* 1940; *Glyn* 1984; *Hewlett* 2091. Exception taken to the accuracy of the Armstrong gun; *Seymour* 1993. 1996. 1998. 2022; *Gardner* 2701. The 20-pr. naval Armstrong gun not as accurate as the other natures; *Bechervaise* 1203. Corrections possible by the eye for accuracy at 3,000 yards' range for distances not under 200 yards; *Milman* 732. Evidence of the extreme accuracy of the Whitworth guns; *Alderson* 623; *Milman* 736-768; *Boxer* 1621; *Hewlett* 2051; *Gardner* 2731. Accuracy of the shunt gun; *Milman* 813.

#### ADAPTER, FUZE:

Objection to; *Bechervaise* 1292. Opinion favourable to; *Milman* 933. The price of the adapter placed at 6d. and statement that it is not a peculiarity of the Armstrong gun; *Noble* 3678, 3679.

#### ALDERSON, CAPTAIN HENRY JAMES, R.A. (*Analysis of evidence.*)

Is assistant-superintendent of experiments at Shoeburyness. Thinks the Armstrong gun precise at all ranges; 580. Prefers muzzle loaders, if equal to the Armstrongs, for field purposes; 584. The vent-piece the weak point; 587. Considers injury to the breech screw caused by flaws, or carelessness of the men; 591. Does not like side loading for field guns; 596. The male screw of the breech screw generally injured; 603. The 12-pr. Armstrong, when used as case shot, effective as 24-pr. howitzers at 300 yards; 604. For a field battery would prefer four 12-pr. Armstrongs and two short 20-prs.; 605. Prefers the Armstrong 12-pr. to the Whitworth; 615. Believes a shell bursting in the Whitworth brass gun would render it unserviceable; 616. Armstrong gun not thus disabled; 618. Has seen shell jam in the bore of a Whitworth gun; 619. The Whitworth gun is equal to the Armstrong in accuracy and facility of working; 623. At a distance of about 30 yards from a column the Armstrong shell would spread about 30 yards; 627. Thinks the 12-pr. should be shortened; 634. No difficulty from the alteration of form in the Armstrong projectiles; 637. The recoil of the Armstrong gun sharp and more than the smooth bore; 639. In some cases prefers the heavy guns as breech loaders; 646. Working 110-pr. more severe on men than the 68-pr.; 648. Has seen breech screws of heavy guns damaged by vent-piece breaking; stripping will not occur to projectiles with careful loading; 653. The shunt as a principle appears to answer; 655. Believes the new time and concussion fuzes remedy the faults of the old; 659.

Nothing under 300- or 600-prs. would do any real harm to an iron-plated ship; 662. The Whitworth has beaten the Armstrong gun in penetration, but is ineffectual for real damage; 663. Penetration a question of material in the projectile; 666. Has seen successful experiments with 40- and 110-pr. shells filled with molten iron; 673. Recommends elongated projectiles for plunging, but not for ricochet fire; 680. The converted carriages sometimes break with 12-pr. Armstrongs; 688. For ordinary purposes prefers muzzle loaders from their requiring less care; but likes 40-pr. screw gun for siege purposes, and the heavier breech loaders for casemates; 690. Has seen Armstrong guns which were very dirty cleaned and ready to fire in five minutes; 699. Shells bursting in Armstrong guns burr the grooves, but do not injure the accuracy of fire; 702. The ranges of Whitworth and Armstrong 12-prs. with equal charges would be about the same; 707. The latest pattern of fuzes and segment shell are very good; 710. Segment shells fired from field guns are most formidable; 711. Great want of shell gun in field batteries; 713. Pillar fuze effective against wooden ships; 720. The coil system an element of great confidence in the construction of guns; 721.

#### ALTERATION OF PATTERNS:

For the trial of the Armstrong system, Sir W. Armstrong proposes to bring before the Armstrong and Whitworth Committee guns into which all the latest alterations have been introduced; *Armstrong* 118. Proposes muzzle-loading shunt field gun; *ib.* 122. The wedge gun with alterations from its original construction; *ib.* 126-128. Alterations to fuze. *ib.* 161. Toughening vent-pieces in oil and altering form; *ib.* 207. 211-213. 217; *Anderson* 2534. 3018-3043. Alteration to breech screw; *Armstrong* 215; *Anderson* 2398, 2399. The very serious results arising from the frequent change of the Armstrong gun stores, and the impossibility in the present state of things of maintaining a correct supply of stores; *Gordon* 1758. 1797-1805, 1806-1810. Evidence states that the danger of shot sticking in the bores of the Whitworth guns has been obviated by increased windage; *Whitworth* 84. The form of the shrapnel for the Whitworth gun is being determined by Colonel Boxer; *ib.* 114, 115. Alteration in the mode of forging breech pieces for Armstrong guns; *Anderson* 2386-2389. Detail of alteration in the manufacture of Armstrong guns generally; *Anderson* 2397-2401. 2449, 2450. 2499-2506.

#### AMMUNITION:

Witness does not propose any alteration in the mode of carrying ammunition from the method already in the service for field artillery; *Whitworth* 110, 111. Evidence of ammunition that had travelled a number of miles without injury; *Cox, S.* 317. Statement of the injury done to projectiles by travelling; *Gordon* 1819-1822; *Gardner* 2627. 2668, 2669; *Noble* 3642. Ammunition damaged in the limber boxes on the passage to China; *Milward* 1316. No complaints against the Armstrong ammunition but the stripping of the shot; *Glyn* 1971, 1972. The ammunition for the shunt gun slightly cheaper than that for the breech loader; *Noble* 3652.

#### ANDERSON, JOHN, Esq. (*Analysis of evidence.*)

Holds the position of assistant-superintendent of the Royal Gun Factories at Woolwich, and has been conducting those works for the last four years as regards management; 2327. Cast iron, as a gun metal, has many good points; its great defect is uncertainty; is good for resisting compression, but is defective in tenacity, and requires great weight of it to produce guns of proper strength; 2329. Thinks that if hooping were applied, that the defects of cast iron might be got over; cast iron has not been properly applied, but still there are better metals for selec-



tion; 2333. Bronze is an excellent metal, more tenacious than cast iron, but it is also softer; it is, however, a trusty metal from its uniform strength, while wrought iron is uncertain in the welds, becoming more so when the iron is of higher quality, or if the coal used is impregnated with sulphur; 2335. The Austrian metal almost the same as Muntz's, which has been found to fail as a gun metal owing to the zinc melting out; 2340. Sudden cooling of the Austrian metal increases its tenacity; 2342. When the manufacture by the "coil" principle first began, believed that the gun was as strong in the direction of the bore as it was laterally; but found it not so, in the proportion of 10 to 25 tons per square inch; with small coils there is not rigidity enough to receive a good blow in welding; 2350. To get a good gun pure iron is required, and the purer the iron the more difficult it is to weld; it is therefore difficult to make the insides free from defect. A solid inner tube was tried and found to answer; 2351. This inner tube was made from three slabs welded and drawn out, and then bored; its strength is about 22 tons; 2353. This plan was objected to for the 100-prs., as they were said to score, but that was nothing to the mischief caused by the opening of the welds in the coiled barrels; 2356. Coiled barrels not satisfactory; 2359. The loss of circumferential strength of the solid barrel, compared to the coiled one is as 22 tons to 25 or 26 tons; but in the longitudinal direction there is a gain of 10 tons in favour of the solid. Out of 255 12-pr. guns, at first proof, only three failed with the solid barrels; 2363. Out of 360 with the coiled barrels, had to renew the barrels of 160, which was a difficult work; 2366. The welds where two cylinders are brought together are stronger than the coils themselves if properly made; 2373. Considers the coil principle very safe for the outside of a gun; 2377. Prefers a good stiff bar that will bear a blow for making a coil; 2380. A large forging of wrought iron will not answer for guns; 2382. By the coil principle it is possible to obtain an iron of good quality, and trustworthy; 2383. The breech pieces were first made of two shells welded together, which was not sound, only giving a strength of 10 tons; 2388. They were afterwards made of a solid forging, increasing the strength to 22 tons; 2389. Out of 202 20-prs., with solid inner tube, none have been returned for repair, and from 239 110-prs. eight have been sent for repair; 2395. Five points of difference in the superiority of the new sea service 12-prs. over the old pattern with coiled barrel. The breech screw a great point of weakness, the new pattern thread of which is 20 to 25 per cent. stronger than the square thread; 2398. For land and sea service, 625 12-prs. have been made at the gun factories, and not more than 65 at Elswick; 2404. Considers a perfect 12-pr. should have a steel lining, and an addition to the breech screw; 2409. Recommends dependence for strength and safety on the coils outside the gun, while steel should only be used with discretion for the inside. Would not venture upon steel for an entire gun; 2412. A steel lining to a gun gives the advantage of a perfect and hard inside, and will not be injured much by shells, and gives a uniform strength, longitudinally and circumferentially; 2419. In a comparison between a solid forged and a built-up gun, the latter would be the best; 2432. There is much difficulty in forging the breech piece for the 70-pr. Armstrong wedge gun owing to the hole in it being limited to five inches; 2433. Coiled guns give great facility for inspection during manufacture—solid forged guns do not; if the latter were to burst they would do so without warning; 2444. The Horse Artillery 9-pr. made of a thickish coil, and gives a strength of 14 tons, and is better than the original 12-pr. A good many of them failed in proof from having spots in the bore, and had new barrels put in; 2450. Sir William Armstrong never liked the solid inner barrel system; 2459. Does not consider that the friction from hard metal surfaces of the shot will ever wear out a gun; it depends upon the amount of bearing surface, and does not anticipate injury to the Whitworth form of bore from this cause; 2473. Is of opinion that the form of rifling a gun has little effect on its bursting tendency; 2477. Prefers a uniform to an accelerating twist in rifling; 2487. Does not approve of the plugged up barrel plan for 300-pr.; prefers the tube solid and supported behind with a screw, or, better still, with a solid forged breech piece; 2488. Mr. Whitworth's 120-pr. made

in the gun factories had a forged iron barrel with a solid end; 2490. In the coil gun it is a matter of judicious arrangement of the joints, whether the gun is good or bad; 2499. Witness describes different modes of construction; 2500. Nothing can be worse than proving guns with too heavy charges; 2501. Does not approve of the breech-loading principle; 2506. The 12-pr. breech-loading Armstrong gun is about as good a gun of its kind as can be made, but it has many faults. Does not think the breech screw strong enough, and if the vent-piece is not heavy it will break; the copper bushing is liable to injury; 2514. The vent-pieces are made of steel at Sheffield; 2526. The breech screw not being home on the vent-piece renders the latter liable to break; 2529. The vent-pieces of Swedish iron do not break as readily as steel; but on tempering steel vent pieces in oil, found they stood a very severe proof; 2534. Does not remember that the fracture of the vent piece or breech screw has ever caused injury to the gun; 2542. Agrees with Colonel Taylor's commercial method of estimating the value of a gun; 2545. The amount of tools to be carried for the repair of large guns is formidable; the work has to be done with great accuracy, and the tools could not be done without; 2552. The wedge system does not offer the same facility for repairs as the screw breech loader; 2558. Nothing done yet to call forth the powers of the wedge gun; 2582. Would not recommend the shunt form of rifling; 2584. In the shunt portion of the gun the shot at a high velocity has to do more work, requiring a conformity of fit in gun and projectile equal to the occasion; 2593. Thinks that any incline will cause a shot to twist to a centre in leaving the gun; 2596.

#### *Further examination.*

Details again the principal points of former evidence; 2966. States that in the construction of the Armstrong guns in 1862-3, that  $24\frac{1}{2}$  per cent. of the 110-prs. have been condemned either before or after proof,  $28\frac{1}{2}$  per cent. of the 40-prs., 29 per cent. of the 9-prs.,  $10\frac{1}{2}$  per cent. of 6-prs., and, taking an average of the whole, it would be  $26\frac{1}{2}$  per cent. These losses are included in the cost of the guns; 2967. Considers that a modification of the breech-loading system of Cavalli-Krupp and the Armstrong wedge would make a good method of breech loading; 2971. Describes the difficulties of repair to the wedge system, and thinks it would not be far wrong to try a gun with a steel lining and a Krupp's wedge with a sunk cup; 2977-2990. Has not seen any plan of breech loading that will give entire satisfaction; 2999. Does not think the Whitworth breech loading for large guns will give satisfaction to anybody for a length of time, considers a muzzle-loading gun the best for all purposes; 3001. Prefers the hard surface to the projectiles and believes that the lead coating will deteriorate sooner or later; 3002. The effect of the bursting of shells in a gun where there is hard metal in both gun and projectile is as the relative hardness of the metal composing each. Believes that Mr. Whitworth's gun, if of wrought iron, would be injured considerably in this way. Thinks that this requisite hardness will be arrived at in steel tempered in oil, which requires a precise temperature to be adhered to; 3015. Describes the oil tempering process; 3018-3044. In speaking of the coil system restricts objection entirely to the inner barrel, which has been the cause of all the failures; 3048. Considers that a structure of one entire metal such as steel would be better for a gun than being built up. But would not use steel until more is known about it; 3052. Thinks that if the 110-pr. Armstrong were used a long time it would give way; 3058. The question of breech loading resolves itself into the probable advantage it may be to the service, and not to be decided as a mechanical subject; 3066. Up to the 40-pr. the objections to breech loaders are not so important as in heavier artillery; 3070. Describes the method of shrinking on the solid breech piece, and the tension due to shrinkage of coils; 3073-3082. According to theory, it is wrong to put a soft material outside a hard one, although as far as our practical experience goes it is safer; 3085. Theory points to a steel gun covered with steel hoops. Could not, however, recommend it now; 3087. The Whitworth principle of forcing on hoops cold has in it an immense deal to be considered; 3090. Homogeneous iron described; 3092-3096. Krupp's steel too soft for the inside of a gun. The Bockum steel is harder; 3098. Describes instances of failures in outer coils;



3109-3115. Besides 12-prs. there were some Elswick 40-prs., 20-prs., and 12-prs. lined; 3122. Having been shown the muzzle of an Armstrong gun that blew off, considered the accident due to a jam of the shot in the bore, and a fault in the welding of the coil; 3135. From observing a Whitworth shot which had been fired from a brass gun, infers it fitted badly, and that a brass gun would not last if fired with such shot; 3142. Recoil might be checked by mechanical means, and it is possible that if wrought-iron carriages were used lighter guns could be adopted; 3153-3158. Thinks that for driving a shot concentrically out of the bore, that, mechanically speaking, two driving surfaces would be most accurate. But it would give the gun too much to do at those parts; 3171-3175. Prefers Mr. Whitworth's to the shunt form of rifling; 3179. Considers Mr. Whitworth gives his gun a great deal of work; 3181. No rifling more easily done than the multigrooved system. The Whitworth would be easier done than the shunt rifling; 3203. Does not see any means of getting a good gun to answer equally well for a smooth bore as for a rifle; 3216.

#### ARMAMENT:

Witnesses consider that ships of war will have to carry guns of much greater weight than heretofore to enable them to contend against armour-plated vessels; *Armstrong* 164; *Hay* 1841. Evidence of the necessity for adding shell guns to the armament of field artillery; *Alderson* 605, 713; *Milman* 842-844; *Milward* 1322-1329; *Desborough* 1447-1450, 1466; *Boyer* 1586, 1587; *Hewlett* 2121; *Gardner* 2616-2618. Opinion favourable to the use of Armstrong guns for the armament of ships' broadsides; *Hay* 1840. Witness prefers the 68-pr. smooth bore for the broadside armament to the 110-pr. Armstrong; *Rice* 1942. Evidence mentions that if allowed to choose he would not have an Armstrong gun amongst the armament of his ship, but would prefer the 68-pr.; *Seymour* 2025. Witness considers that the principal armament of our ships of war should still be smooth bores, rifle guns being also supplied for special purposes; *Hewlett* 2149-2151. Statement that in arming a ship the witness would select the minority of Armstrong and the majority of muzzle-loading guns; *Powell* 2281, 2282. Witness states that the armament of coast batteries should depend very much on the depth of water. If deep enough for armour-plated ships to come alongside, would prefer the 68-pr. smooth bore; *Gardner* 2703-2705. Recommendation that smooth-bore ordnance should form a portion of the field artillery armament in the proportion of about half smooth bores; *ib.* 2729, 2730.

#### ARMSTRONG SIR WILLIAM, C.B. (*Analysis of evidence.*)

Proposes the 6, 9, 12, 20, 40-pr. for field service, also a muzzle-loading field gun on the shunt plan; 116-122. The whole of those guns to be on the coil system, and the mode of breech loading, the hollow breech screw, with vent-piece. Has always preferred a steel barrel for all guns, but has had much disappointment from the uncertainty in the quality of steel, but expects the time not far distant when that metal can be safely used; 123. Two or three modes of forming the steel block. Considers vent-pieces may be made of steel to stand anything. The strain on the breech piece being longitudinal its formation is different to the coils, being forged with the fibre placed longitudinally; 125. Always was of opinion that large breech-loading guns should load from the side. At first the gas escape was serious, but a continuance of experiments eventually produced a construction by which the former objections were obviated; 126. Prefers the screw breech-loading arrangements for the 40-pr. and all smaller guns, and the side movement for the larger natures. Describes the side-loading principle; 128. Proposes steel for the inner barrels as a means of escape from the imperfect welds that iron is liable to; 129. The first guns made were subject to imperfect welds, and some gave way crosswise; 134. Believes that if a properly manufactured gun on this principle is taken that it will be impossible to burst it; 136. Considers the steel lining would obviate the damage of shells bursting in the bore. The bursting in the 9-pr. shells caused by old pattern time fuzes being used in connexion with new pattern concussion; 139. Describes powder and shot chamber and rifling, and the projectiles; 140. Does not object to air space behind projectile, but thinks that the cartridges should be

long enough to fill the longitudinal space; 144. Service charge one-eighth the shot's weight. Was led to adopt breech loading from the particular nature of the projectile chosen, which, covered with a soft material, was intended to fill the grooves on being driven forward, and it therefore became necessary to introduce it from the rear; 146. Details the advantages of breech loading, and has considered it a matter for the service to choose whether they should use breech or muzzle loading, as he is prepared to propose muzzle-loading guns for the field, or large guns on the shunt plan if required. The projectiles would be internally the same as before, but instead of lead coating would have six brass studs; 147. Considers there is no danger now with vent-pieces in field guns; 159. The old pattern fuzes were liable to be injured by moisture. The present pattern are not so; 161. In a breech-loading gun the time fuze must be ignited by a detonating principle. Observes there is much difference of opinion as to the calibre of a rifle gun. Large calibre give the most destructive shell, while small calibre attains the greatest penetration. Thinks that any one form of rifling has no advantage over another, provided sufficient rotation and steadiness is given to projectiles. The Armstrong gun, as first introduced, was not intended to contend against iron-plated ships, and considers that much larger guns will be required for this service, and proposes 300-pr. of 12 tons, with projectiles suitable to the service it is required to perform; 164. Larger bores give higher initial velocity, which is not maintained so long as the smaller bores; 168. Velocity not checked but rather increased by lead coating on the projectiles; 173. Considers it desirable to use large grain powder in the large guns. The smaller guns are little affected by the kind of powder used; 176. Designed the 70-pr. shunt shell, so as to prevent injury to the bore of the gun by the friction of the rough portion of shell, but considers that by the perfection of casting now arrived at this becomes unnecessary to provide for; 180. Has no very definite rule as to the length of shot. Considers 2½ calibres good length for a shell; 188. The rapidity of twist in field guns should be about one turn in 38 calibres. It is a complex question to determine the proper twist. Have given the 300-pr. one turn in 65 calibres; 190. The twist should be uniform throughout. There are two causes of unsteadiness to projectiles—eccentricity of their centre of gravity and the resistance by the air to them, to counteract which respectively it is necessary to have the centre of gravity of shot far back for the first, and for the other far forward; 191. Can produce a shell for the 12-pr. if required. There is a common shell for the 20-pr. containing 1 lb. of powder, and the gun of that calibre would recommend as a howitzer of about 13 cwt. Proposes a 7-inch howitzer for siege and garrison use; 193. Concurs in the proposal to have batteries of shell guns in the service; 195. The process of toughening in oil has increased the strength of the vent-pieces enormously; 207. The cases in which the inner tubes have moved inside have been owing to the fact that at first the inner tubes were made too thin; 208-210. The blowing out of the vent-pieces obviated by the present change of pattern; 211. The thread of the present pattern breech screw an improvement on the former one; 215. The early vent-pieces were made of steel. They being thought uncertain, iron was found safer. Has now ascertained that a kind of Swedish iron is the best, but a perfect vent-piece would be one of mild steel tempered in oil; 217. Does not consider the temperature of the gun from firing would affect the coils injuriously; 220.

#### ARMSTRONG GUNS:

1st. In approval of the adoption of the Armstrong system.

2nd. Exceptions taken against these guns.

1st. In approval of the adoption of the Armstrong system.

*Cox*, S. 229-234. 285, 286. 294, 352; *Cox*, J. 415. *Alderson* 580; *Milman* 727; *Liddell* 944. 947; *Bechevaise* 1200, 1201. 1205; *Milward* 1327; *Taylor* 1486-1489; *Hewlett* 2049. 2092. 2130, 2131. 2212. Breech-loading not too complicated for general service, *Milman* 916; *Bechevaise* 1272; *Desborough* 1462. Breech loading safe and efficient up to the 40-pr. Armstrong gun, *Armstrong* 127; *Liddell* 1004; *Hay* 1834; *Gardner* 2634. Breech loading preferred to muzzle loading,

*Armstrong* 147; *Cox*, S. 286; *Cox*, J. 442, 447, 448, 478; *Liddell* 1041-1072; *Taylor* 1486; *Hay* 1834, 1844; *Hewlett* 2051, 2092. Breech-loaders preferred for special services, such as for casemates, sieges, and on board ship; *Alderson* 645, 690; *Gardner* 2605; *Hewlett* 2051. Remarkable accuracy and range from the Armstrong gun; *Cox*, S. 230, 231; *Cox*, J. 415; *Alderson* 580; *Milman* 737, 763; *Liddell* 944; *Bechervaise* 1196, 1200, 1201; *Milward* 1331; *Bozer* 1621; *Rice* 1904; *Hewlett* 2049; *Powell* 2269; *Gardner* 2603. Armstrong gun capable of bearing the rough usage of the service; *Liddell* 1064; *Milward* 1365; *Harrison*, R. 1896, 1897. Witness entirely disagrees with the evidence (of *Capt. Glyn* 1947, *Capt. Seymour* 2018) relative to the Armstrong gun being unsuited to boat service; *Hewlett* 2118. Opinions that the Armstrong guns are suited to boat service; *Liddell* 970; *Bechervaise* 1246; *Hay* 1844; *Hewlett* 2110-2112.

2nd. Exceptions taken against these guns.

Opinion that the 12-pr. Armstrong was useless for boat service; *Glyn* 1947. The practice with Armstrong guns in New Zealand not satisfactory; *Seymour* 1993, 1996, 2018. Would not have an Armstrong gun on board ship if permitted the choice; *ib.* 2027. Opinion that the Armstrong gun would not be likely to stand the rough usage of the service; *Glyn* 1947; *Seymour* 2000; *Gardner* 2609, 2645, 2672, 2685. Witness mentions the difficulties in working the 12-pr. Armstrong, and the fouling that he found to take place in the bore of the gun; *Bozer* 1623-1639.

### B.

BARREL. See FORGING.

BASHLEY BRITTEN, ESQ.

Statement of evidence that the zincing process, now used in the Royal Laboratory, was the system that had been carried out by Bashley Britten, Esq., and which had answered well up to the present time; *Bozer* 1687.

BECHERVAISE, MR. EDWARD. (*Analysis of evidence.*)

Is gunner in the navy, employed in the "Excellent." Considers the Armstrong gun everything that could be wished for the service in range and for accuracy, except the shortened 20-pr. which is less accurate than the others; 1204. 40-pr. easily worked as a broadside gun, also the 110-pr. as easy to manage as the old 68-pr., but in firing there is some delay by the tin cups jamming, the vent-piece requiring the use of a lever to free it; 1209. Prefers the muzzle loader as simpler and less complicated than the breech loader; 1218. Saw three accidents with vent-pieces, two caused by breech screw not being home; 1224. In arming boats no difficulty with Armstrong gun; 1246. Very little objection to the sights having to be detached from Armstrong guns; 1254. Ratchet sights would give equally good ranges with the Armstrong gun as the 24-pr. and 12-pr. old smooth-bore howitzer; 1264. No difficulty in surfacing the copper ring of powder chambers, but with the vent-piece there is much possibility of injury to it in refacing; 1269. The comparative elaborateness of the breech-loading arrangement in Armstrong guns is of no objection; 1272. All the vent-pieces are strong enough except the 110-pr.; 1274. Thinks there is no injury to be apprehended to the new pattern breech screws; 1276. Has not seen an Armstrong projectile sufficiently injured from rough usage to prevent loading with it; 1287. Great objection towards using the adapter with different screw to the fuze, either of which loosen; 1292. Considers it inconvenient to have to carry so many appliances, spare, for the Armstrong breech-loading guns, and so much gear and tools; 1306.

BENT, HUGH, CAPTAIN, R.A. (*Analysis of evidence.*)

Is assistant superintendent of laboratory at Devonport; 2754. Has noticed the condition of the bursters as much deteriorated; 2757; also the lead appearing loose on shot and shell, which had been through the tin process, also some from the undercut; 2758. The defect of the zinc process we have only begun to observe, unable to inspect percussion fuzes. Difficult to draw the pillar fuzes when they have been in shell long, and is a dangerous proceeding, recommends them not to be fixed, and that the gas pipe casing of fuzes should be lacquered. Rust forming, the cause of the coating on shell coming off. Desirable to inspect fuzes made by contract in case of any omission in manufacture 2754-2778. Lead coating of shells

becomes damaged from any moving and requires repair to pass gauges, with zinc process a small percentage of blisters occur.

BEST, LIEUT., R.A. (*Analysis of evidence.*)

I have had practice with both Armstrong and Whitworth guns at ranges from 500 to 2,000 yards. Fired 30 rounds from 12-pr. brass Whitworth, one shot was picked up broken, the edges found coated with brass from the gun; 2877. The Whitworth shrapnel and their fuzes did not act well; 2884. It was not caused by any irregularity in preparing the fuzes; 2890. The Armstrong practice was better than that from the Whitworth guns under trial; 2895. The practice from the Whitworth very bad both in range and lateral deviation; 2902. Saw the muzzle blown off an Armstrong gun; sure it was not full of sand when fired, as it had been sponged, the No. 1 reported; 2913. The elevation of the Whitworth guns was frequently altered, and gave uncertain results at the same elevation; 2930. Some dirt got into the muzzle of the Whitworth gun which did not cause any inconvenience; 2935. Some of the shot from the Whitworth gun very irregular in flight; 2939. The guns were well laid; 2945. Likes the Whitworth best for service; 2951. Prefers the muzzle-loading principle; 2953. The shot came out of the Whitworth gun by lifting up the trail of the gun carriage; 2965.

BOAT GUN:

The Armstrong gun, suitable for boat service; *Liddell* 970; *Bechervaise* 1246; *Hay* 1844; *Hewlett* 2110, 2112. Opinion that the Armstrong guns were not fit for boat guns; *Glyn* 1947; *Seymour* 2018. Objections to the use of Armstrong guns in boats; *Powell* 2259-2261.

BOXER, EDWARD MOURRIER, LIEUT.-COLONEL, R.A. (*Analysis of evidence.*)

Has carried on experiments with the Armstrong 12-pr. for the proof of ammunition; 1569. Has made a few experiments with the Whitworth 12-pr. to determine the form for its shrapnel shell, and found the taper to the rear of shell necessary to give increased range; 1570. Nothing more satisfactory than the construction of the Whitworth shrapnel shell; 1576. No difficulty in lighting the common service fuze with them, even when lubricators are used, the windage being sufficient; 1578. Does not consider the Whitworth gun would be sufficient for firing case shot and shrapnel. Advocates a battery of shell guns; 1585. Recommends the same for Armstrong guns; 1587. The Whitworth shot would be shorter than the shell; 1590. Proposes two bursting charges for the shrapnel shell to be used according to range; 1591. Bursting charge very small; 1596. 40 bullets and 10 segments in the 12-pr. Whitworth shell; 1599. If necessary could burst this shell within 20 yards from the muzzle; 1602. Whitworth shell better than the Armstrong; 1603. In shell of the shrapnel nature, objects to the bursting charge being in the centre of the shell, prefers the force from the bursting charge, giving as little distribution as possible; 1608. Whitworth shells give very great longitudinal spread; 1612. The flat-headed Whitworth projectiles appeared very accurate; 1617. The Whitworth and Armstrong guns more accurate than necessary for all practical purposes; 1621. Objects to breech-loading as it exists; 1622. Observed fouling in the chamber of an Armstrong gun after a few rounds; 1633. Whitworth projectile not likely to jam if sufficient windage be given to it; 1644. Has fired 400 rounds with Whitworth guns, and has not known a shot to stick in the bore; 1645. No difficulty in ensuring a supply of accurate shot for Whitworth guns; 1649. Less chance of unconsumed cartridge being left in rifle guns than in smooth bores; 1655. Believes a gun on the Whitworth system would give as much endurance as an Armstrong gun; 1657. If made of the same iron, the cost of the Whitworth projectile is less than the Armstrong; 1666. Estimates the cost of the Whitworth projectiles to be less than the Armstrong; 1667. Has found the fuze holes of the old pattern Armstrong shell much out of the centre; 1677. Has not observed loosening of the lead coating with the zinc process, but would not say that even that would stand all climates; 1684. Nothing to fear from the strain of the Whitworth rifle twist if the gun be of wrought iron, steel, or brass; 1688. Unless the rotation were rapid the Whitworth



shot would turn over in flight; 1689. Can see no objection to shot of different lengths being fired from the same gun; if sufficient rotation can be given to the long one, length will not affect the efficiency of a shell; 1691. Has seen some shells burst in a Whitworth gun, and not injure the bore; 1694. No reason why the common fuze should not be used with the Armstrong shell if a detonator be added; 1704. Does not think the Armstrong concussion fuze of much use as a means of bursting the shell on striking. Considers time fuze too complicated, and not fit for actual service; 1705. The india-rubber disc an objection to the Armstrong time fuze, and independent of that, has doubts about the keeping qualities of present pattern fuze; 1710. Considers the pillar fuze answers the purpose it was intended for, but is too delicate and dangerous for the service; 1725. The detonating composition of the Moorsom fuze has not been found liable to deteriorate in hot climates; 1729. Believes that penetration would be greater with a flat than with a round-headed shot if the target were inclined, but if vertical they would act about the same; 1735. The expense of reloading the unserviceable Armstrong projectiles is about 10% per hundred; 1740.

#### BREECH LOADING:

- 1st. Breech loading as a system.
- 2nd. The Armstrong breech loader on the screw and vent-piece principle.
- 3rd. The Armstrong wedge gun.
- 4th. The Whitworth and other breech loaders.

##### 1st. Breech loading as a system.

General approval of breech loading; *Armstrong* 147; *Cox*, J. 442. 468. 478; *Liddell* 1041. 1072; *Taylor* 1486; *Hay* 1834. 1844; *Hewlett* 2051. 2092. 2154. Opinions opposed to breech loading; *Whitworth* 53; *Alderson* 584; *Milman* 879, 880; *Bechervaise* 1217; *Milward* 1374. 1379; *Desborough* 1463; *Bower* 1622. 1641; *Seymour* 2015; *Powell* 2281; *Anderson* 2506. 2514. 2999; *Gardner* 2611. 2677. 2679. Want of confidence in breech loaders; *Hay* 1834; *Rice* 1910; *Seymour* 2014; *Powell* 2252. Breech loaders more liable to injury than muzzle loaders; *Cox*, J. 449. 467; *Milman* 917; *Powell* 2254. The question of breech loading resolves itself into the probable advantage it may be to the service, and should not be considered as a mechanical subject; *Armstrong* 147; *Anderson* 3066. A breech-loading gun best adapted for firing from cupolas; *Liddell* 974. The comparative elaborateness of breech-loading Armstrong gun is no objection to it for general service; *Bechervaise* 1272.

##### 2nd. The Armstrong breech loader on the screw and vent-piece principle.

General description of the manufacture of these guns; *Armstrong* 123-126; *Anderson* 2350. 2359. 2398. Confidence felt in the Armstrong breech loaders; *Hewlett* 2158.

##### 3rd. The Armstrong wedge gun.

A misnomer to call the wedge gun a side-loading gun; *Armstrong* 204. A description of the wedge gun; *Armstrong* 126-128. General approval of the wedge gun; *Cox*, S. 390. 398; *Cox*, J. 539; *Milman* 796; *Hewlett* 2078; *Gardner*, 2613. Opinion recommending the introduction of the wedge principle into all guns, provided it will stand heavy charges; *Hewlett* 2080. Recommended for heavy guns only; *Cox*, S. 396. The necessity of extra wedges being supplied to each gun; *Gordon* 1764-1768. Out of three wedge guns two required repair after the proof; *Gordon* 1772. The difficulties of repair increased by the introduction of the wedge gun; *Anderson* 2558-2573. 2977-2983. Opposed to the use of the wedge principle for field guns; *Alderson* 596. The wedge gun quicker to work than the screw breech loader; *Cox*, S. 398.

##### 4th. The Whitworth and other breech loaders.

Witness expresses his willingness to produce breech loaders for trial before the Committee, but does not recommend such a system; *Whitworth* 13. 51-53. Evidence mentions a trial at Shoeburyness between Armstrong and Whitworth 12-pr. breech-loading guns, but that Mr. Whitworth had given up breech loading; *Taylor* 1481-1484. Opinion that Mr. Whitworth's breech-loading arrangements were very defective; *Hewlett* 2051. Witness does not think the Whitworth breech loader will give satisfaction; *Anderson* 3001. Evidence of the excellence of range and accuracy of the Whitworth gun; *Cox*, J. 500. 521; *Alderson* 623. 706; *Milman*, 735; *Boxer* 1621; *Gardner* 2731. The breech-loading system of Mr. Westley Richards mentioned, as likely to remove all objections to breech-loading; *Hay* 1835. Captain Cavalli's breech-loading gun and its failure alleged as a precedent for an objection to the principle of hard metal in a projectile working against the metal of the gun; *Hewlett* 2093-2095. Statement made relative to different plans for breech loading, such as the Warendorf, Cavalli's, Church and Goddard, Armstrong and Krupp, and opinion given that a plan combining the good points of the systems of Cavalli, Armstrong, and Krupp would make as good a breech loader as can be made; *Anderson* 2971. Opinion that the introduction of a steel lining, a Krupp's wedge with the sunk cup should not be very far wrong, 2990.

#### BREECH SCREW ARMSTRONG:

- 1st. Hollow screw for breech loaders.
- 2nd. Solid screw for muzzle loaders.

##### 1st. The hollow screw.

Mentioned as a portion of the Armstrong breech-loading system; *Armstrong* 123. The liability of the old pattern thread of this screw to strip; *Armstrong* 215; *Cox*, S. 250. 263. 278; *Cox*, J. 437. 459; *Alderson* 589. 598. 603; *Liddell* 1147. 1155. 1157; *Bechervaise* 1277; *Hewlett* 2159; *Anderson* 2398; *Gardner* 2679. A change of form in the thread of the screw renders it less liable to break, and makes it stronger; *Armstrong* 215; *Liddell* 1147; *Bechervaise* 1278; *Anderson* 2398. Opinion that the breech screw is not strong enough in the 12-pr.; *Anderson* 2515. The breech screw sometimes damaged by the breaking of the vent-piece; *Cox*, J. 440; *Alderson* 650. Complaint that the breech screw got so stiff that it was difficult to work; *Boxer* 1624; *Gardner* 2634. In landing an Armstrong boat gun, would recommend the breech screw to be taken out; *Hewlett* 2114; *Powell* 2261.

##### 2nd. Solid screw for muzzle loaders.

The method of supporting the interior barrel of large muzzle-loading guns by means of a solid screw explained; *Anderson* 2488; *Noble* 3572-3578. Method of dispensing with solid screw, and using solid breech-piece; *Anderson* 3074.

#### BREECH PIECE:

The difficulty of forging large breech piece; *Anderson* 2433. The old method of forming breech piece; *ib.* 2387. The present method of making the breech piece solid; *ib.* 2400. Opinion given that the breech piece for large guns should be solid, and without the supporting screw; *ib.* 3074. The breech piece a means of conveying the strain from the breech to the trunnions; *Noble* 3582-3584. 3587-3592.

#### BREECHING ROPE:

Statement that it was considered necessary to give the 40-pr. a stronger breeching rope in consequence of the excessive recoil of that gun. But from experiments it had been shown that a 32-pr. gun breeching rope had been sufficient for a 40-pr. during 1,000 rounds; *Liddell* 1159-1166; *Hewlett* 2147.

#### BROADSIDE:

Witness details the disadvantages of the Armstrong gun for broadside use on board ship; *Liddell* 986. The 40-pr. Armstrong worked admirably as a broadside gun; *ib.* 1004. The advantages of the Armstrong gun for the broadside is the rapidity of fire over the smooth bore, except the 110-pr.; *ib.* 1028-1041. The 40-pr. is easily worked as the 32-pr. smooth bore on the broadside; *Bechervaise* 1207. Witness would prefer the Armstrong guns for the broadside. It would be necessary to have heavy guns for the broadside to contend against iron-plated ships. Would limit the weight of gun to about five tons; *Hay* 1840, 1841; *Rice* 1935. Witness prefers a smooth bore for a broadside gun from the rapidity of loading possible with it; *Seymour* 2031, 2032. Opinion that broadside guns should not be more than six tons weight; *Hewlett* 2083. Witness sees no objection to 10 tons for a broadside gun if every necessary appliance for working be supplied; *Powell* 2266.

## BRONZE OR BRASS:

Of the competitive guns offered by Mr. Whitworth to the Committee one 12-pr. muzzle-loading gun is made of brass; *Whitworth* 62. Witness considers that brass is comparatively inferior to wrought iron for guns, and mentions the circumstance of the bore of the brass muzzle-loading Whitworth gun becoming burred; *Cox*, *S.* 228. 303. Additional evidence as to shot sticking in the bore of the brass muzzle-loading Whitworth 12-pr.; *Cox*, *J.* 509, 510; *Alderson* 619, 620; *Taylor* 1498-1500. Witness mentions the muzzle-loading field guns of Mr. Whitworth as being of brass; *Milman* 740; *Taylor* 1485. Experiments of Colonel Boxer made with brass 12-pr. Whitworth gun; *Boxer* 1573. Experiments with Whitworth's brass howitzer for penetration through water; *Hewlett* 2168. The application of bronze as a gun metal; *Anderson* 2335-2339. Experiments with Whitworth's brass guns. Wearing of the grooves observed; *Isacke* 2835-2837; *Best* 2874. 2891; *App.* 165. Witness infers that a brass rifle Whitworth gun would not last long; *Anderson* 3142.

## BURSTING:

The bursting of shells in the bores of Armstrong guns no serious injury to them; *Alderson* 618. 701, 702; *Liddell* 1128; *Milward* 1387; *Taylor* 1504; *Hewlett* 2049. The effect of bursting shells with small bursting charges in the Whitworth gun not injurious; *Boxer* 1694. Opinions of the bad effect of bursting shell in Whitworth brass guns; *Alderson* 616; *Taylor* 1498. Security from bursting felt in using the wrought-iron coil gun; *Alderson* 721; *Liddell* 1148; *Anderson* 2412. Bursting of the 150-pr. smooth bore; *Taylor* 1555. Bursting or splitting of the Whitworth 80-pr.; *Gordon* 1760; *Hewlett* 2068. 2076. Bursting of two cast-iron rifled Lancaster guns at Kinburn adduced as a reason for objecting to muzzle-loading rifle guns for naval service; *Seymour* 2033. The bad effects of bursting shells in the bores of Armstrong guns would be obviated by the introduction of steel barrels into the guns; *Armstrong* 139; *Anderson* 2419. Bursting at the muzzle of an Armstrong 12-pr.; *Best* 2905. Evidence of the bursting of a Whitworth gun supplied to the Danes; *Whitworth* 3871. 3886-3891. 4039.

## BURSTING CHARGES:

Importance of large bursting charges in shells; *Armstrong* 164. Statement of the effect of bursting segment Armstrong shells in front of a column of troops; *Alderson* 627. Witness mentions the increase of bursting charge found necessary for Armstrong segment shell; *Alderson* 632. Bursting charges for various shells mentioned; *ib.* 715-718. Witness states that with the old bursting charge the shell for Armstrong field guns did not break up, but the new bursters act well; *Milman* 935. Witness prefers a shell for the field with larger bursting charge than the 12-pr. Armstrong shell; *Desborough* 1451. Evidence proposes two bursting charges for the Whitworth shrapnel shell to be used according to range; *Boxer* 1591. The change of bursters for Armstrong segment shell liable to cause inconvenience where the old and new patterns exist; *Gordon* 1810. Witness mentions the advantage of having the bursting charge in the centre of the Whitworth 12-pr. shrapnel shell; *Boxer* 1604. Deterioration of the iron bursters for Armstrong shell; *Bent* 2757.

BUSHING. See FACING.

## C.

## CALIBRE:

The calibre of the Whitworth system of ordnance detailed; *Whitworth* 1. 3. 4. 7. 10. 14. 27. 30. 41. 43; *App.* 161. Calibres of Armstrong guns; *App.* 159, 160. Witness states that large calibre has the advantage of enabling a shell to be used with a great capacity for powder, thus increasing its effect, while the small calibre has more penetrating power and gives more range; *Armstrong* 164. Calibre of the 300-pr. Armstrong gun; *ib.* 166. Mentions 2½ calibres as a good rule for length of shell; 188. The calibre of the Armstrong and Whitworth 12-pr. guns contrasted; *Alderson* 626. Opinion that the smallness of calibre of the Armstrong guns used in the naval service is more than compensated by the greater bursting charge in their shells; *Liddell*, 1159. Witness would not wish to have the calibre of

the 12-pr. Armstrong gun smaller. Would prefer it larger; *Milward* 1394. The calibre of the Whitworth 120-pr. (so called) and the Armstrong 110-pr. is the same, namely seven inches; *Taylor* 1514-1516.

## CANADA:

Witness mentions the injury to the lead coating of the Armstrong shells in Canada, and the advantage that would accrue to the use of 20-pr. Armstrongs in the field batteries in that country; *Gardner* 2627. 2668, 2669. 2697.

## CARRIAGES:

Witness mentions weight of the carriage for 1-pr. Whitworth gun, and does not propose any alteration in the 9 or 12-pr. Whitworth gun carriage; *Whitworth* 1, 2, 109. Witness mentions that the 20-pr. Armstrong gun had not been tried on a proper carriage, and states that recoil is of no consequence in field artillery when the carriages are uninjured thereby. The converted carriages for 12-pr. Armstrong guns break; *Alderson* 611, 612. 688. Witness mentions the weakness of Armstrong field gun carriage; *Milman* 887, 888. The carriages sent to China with Armstrong 12-pr. of 6 cwt. were of very faulty construction, and they failed; *Milward* 1332. Statement of the difficulty of moving an Armstrong gun from its boat to its field carriage, and complaint that the boat carriage is raised and takes up too much room; *Glyn* 1947. 1955. Opinion that a slide carriage with mechanical appliances would be necessary for a broadside gun of 6 tons weight; *Hewlett* 2083. Objection to the carriage of 110-pr. Armstrongs on board ship as not permitting of sufficient training of the gun; *Powell* 2229. Witness mentions the difficulty of constructing a carriage to withstand the shock of a light gun, and recommends wrought iron for gun carriages; *Anderson* 3154. 3158.

## CARTRIDGES:

Opinion that the use of flannel cartridge may be dispensed with by using Brown's solidified powder; *Whitworth* 54. Originally the communication to the cartridge of Whitworth gun was too small. Mention made of the extractor necessary for Whitworth cartridges; *Whitworth* 94, 95. Desirable that the cartridge should be the whole length of the powder chamber; *Armstrong* 144. Mention made of the difficulty in withdrawing the metal case of the cartridges of the Whitworth gun; *Taylor* 1481. Complaint of the cartridge of an Armstrong gun projecting three or four inches outside the chamber from the shot not being sent home from the fouling of the gun; *Boxer* 1632, 1633. Statement that it is preferable to ignite a gun cartridge in the centre, more especially of gun cotton; *Whitworth* 3922.

## CASEMATES:

Opinions as to the advantages of a breech-loading gun for the armament of casemates; *Armstrong* 147; *Cox*, *J.* 478; *Alderson* 645. 689, 690; *Hay* 1834; *Gardner* 2605.

## CASE SHOT AND GRAPE:

As a substitute for case shot recommends the Armstrong segment shells carried in the axletree boxes to have the fuzes fixed at zero; *Milman* 837. Witness has greater confidence in the Armstrong segment shell than in the old grape and case shot; *Liddell* 1138, 1139. Witness thinks that the segment shell is not equal in effect to grape and case from a howitzer; *Seymour* 2043.

CAST IRON. See IRON.

## CHAMBERS:

Statements that the powder chamber is the part of the Whitworth gun that wears; *Whitworth* 104. 4073. The formation of the powder and shot chamber in the Armstrong gun explained; *Armstrong* 140. No instances of deterioration in the Armstrong gun powder chambers; *ib.* 175. Some longitudinal scoring in the powder chamber of certain Armstrong guns the cause of abandoning the plan of making the inner tubes from solid forgings; *Anderson* 2460.

## CHARGE:

Rule given for charge for Whitworth guns as one-sixth the weight of its shot of three diameters in length; *Whitworth* 16. Statement of the service charge for Armstrong guns being one-eighth the



weight of the projectile; *Armstrong* 146. The proof charges of Armstrong 12-pr. consist of two rounds of 3 lbs. and five of 2 lbs.; *ib.* 136. Opinion that the proportion of charge to projectile which is used in the Whitworth gun could not justifiably be used in the Armstrong gun in consequence of the construction of the latter not being intended to bear it; *Taylor* 1512, 1513, 1522. For the general detail of charges for Armstrong and Whitworth guns; *App.* 159-161. For charges used in the penetration of brick, earthwork, and oak with Armstrong gun and Whitworth gun into oak; *App.* 158. The powder chamber of the 12-pr. Armstrong could contain 2 lbs. of powder; *Milman* 864. Opinions that for the penetration of iron plates the greatest effect will be produced by the gun standing the heaviest charge with a projectile of proper material; *Harrison, A.* 1414; *Hay* 1832. The heavier Whitworths at Shoeburyness have been fired with much larger charges than the corresponding Armstrong guns; *Taylor* 1511-1514. Statements that muzzle-loading guns give the best promise of success against iron plates from their being able to stand heavy charges; *Harrison, A.* 1435; *Hay* 1841; *Hewlett* 2092, 2187. Evidence considers that the Armstrong guns are not fired with charges proportionate to their bores; *Whitworth* 3836-3855.

#### CHINA:

The general result from the use of the Armstrong guns in China and detail of the services performed by those guns in the war of 1860; *Milward* 1307-1400; *Desborough* 1445-1479; *Harrison, R.* 1863-1899. (See Analysis of the evidence of these officers. Allusions made to the experience gained in the use) of the Armstrong guns in China, founded on the reports of Lieut.-Colonel Barry and Major Hay, Royal Artillery; *Gardner* 2619, 2645, 2656.

#### CLEANING:

The Whitworth gun capable of being cleaned and ready to fire as soon as a smooth bore; *Whitworth* 83, 88-93. Evidence that the breech screw of 12-pr. Armstrong could be cleaned in two or three minutes; *Cox, S.* 277. No necessity to clean the Armstrong gun in practice with it since the introduction of the lubricator; *Cox, J.* 565-576. Evidence of the rapidity with which an Armstrong gun can be cleaned and ready to fire; *Alderson* 696-699; *Milward* 1365, 1366; *Taylor* 1491; *Harrison, R.* 1896, 1897.

#### COAST DEFENCES:

Evidence that the armament for coast defences should be 68-prs. if the range is short, and the largest smooth bores would be invaluable under such circumstances; *Gardner* 2614, 2703-2705.

#### COATING TO PROJECTILES:

The coating of Armstrong projectiles liable to strip more or less on firing; *Cox, S.* 356-359; *Alderson* 582; *Milman* 936; *Taylor* 1566, 1567; *Gordon* 1788; *Glyn* 1972, 1973; *Seymour* 1993; *Hewlett* 2204. Since the method of attaching the lead coating to the Armstrong projectiles by means of the zinc process, the stripping has been obviated; *Cox, S.* 361; *Alderson* 582; *Taylor* 1566; *Boxer* 1684, 1687, 1739; *Gordon* 1791; *Hewlett* 2204, 2205. The method of attaching the lead coating by means of the tin process was defective, and caused stripping and separation of the metals; *Cox, S.* 408-410; *Boxer* 1680, 1682-1687; *Gordon* 1783-1788, 1792; *Glyn* 1990; *Hewlett* 2204. Opinion that the stripping of the Armstrong projectiles is of no practical disadvantage; *Milman* 936-939; *Milward* 1383-1385; *Taylor* 1566-1568. Evidence of the advantage of a coating of soft metal on rifle projectiles; *Armstrong* 147; *Alderson* 618; *Taylor* 1505; *Hay* 1836, 1838; *Hewlett* 2076. Cost of releading Armstrong projectiles by the zinc process about 10l. per 100; *Boxer* 1740. Witness mentions that he noticed that the gradual loosening of the lead on Armstrong projectiles, first on those of the tin process then on the undercut system, and those on the zinc plan seem to suffer from blisters, but has only now begun to observe defects in them; *Bent* 2758, 2759, 2771, 2794-2796. Some of the Armstrong projectiles so knocked about when returned from ships that they would not pass the gauge; *ib.* 2783-2786, 2793. Evidence in favour of attaching lead coating to shells by undercutting, considers it more economical than the zinc process; *Noble* 3623-3647.

#### COIL SYSTEM

Witness mentions that the Armstrong guns are all made on the coil system, as well as other guns made for experimental and competitive purposes, Mr. Whitworth having availed himself of it; *Armstrong* 123; *Taylor* 1526-1528; *App.* 155. Statement that the Whitworth guns are made upon a different principle from the Armstrong coil system; *App.* 157. The construction on the coil system an element of confidence in the use of the Armstrong guns; *Alderson* 721; *Liddell* 1148; *Taylor* 1531; *Hewlett* 2157; *Anderson* 2377, 2412; *Gardner* 2718, 2719. The construction of guns on the coil system fully given; *Anderson* 2350-2598, 2966-3224. (See Analysis of his evidence.) Superiority of the coiled or built-up gun to one made of a solid forging; *ib.* 2432, 2433. Want of strength in the coils in a longitudinal direction; *ib.* 2350-2362. The circumferential strength of coils about 26 tons per square inch; *ib.* 2362. Coiled barrels or inner tubes were not satisfactory from the difficulty of making them with perfect welds, and from their weakness longitudinally; *ib.* 2359. In the manufacture of coiled guns there is great facility for inspection during the various operations; *ib.* 2443, 2444. On the judicious arrangement of the coil depends whether the gun is good or bad; *ib.* 2499. Statement of the tensional strain on the coils of Armstrong guns; *ib.* 3077-3082. Witness considers steel hooped a-coil gun; does not trust to the steel barrel for strength of the gun, but to the coils placed over; *Noble* 3299-3302, 3316-3322. Wrought-iron barrels have been abandoned at Woolwich for coiled barrels, the former being a failure; *ib.* 3350-3353, 3472. The coil gun made up of a number of sections not united except in the second tube; *ib.* 3354-3357.

COLES, CAPTAIN COWPER. See CUPOLA.

#### CONFIDENCE:

Evidence showing the confidence felt in the use of the Armstrong gun; *Alderson* 721; *Liddell* 1149; *Taylor* 1531; *Hewlett* 2130, 2158. Evidence of the want of confidence in the Armstrong gun felt in the Royal Navy; *Hay* 1834, 1835; *Rice* 1910; *Seymour* 2014; *Powell* 2252. The Armstrong gun not well known in the fleet, and therefore there is want of confidence in it; *Hewlett* 2131.

#### CONDEMNED GUNS:

Evidence of the per-centage of guns condemned in the Royal Gun Factories during the year 1862-1863; *Anderson* 2967.

#### CONSTRUCTION:

Statement as to the construction of the Armstrong screw and wedge breech loaders; *Armstrong* 122-128. (See Mr. Anderson's evidence.) Opinion given that an error in the construction of the 150-pr. probably caused its destruction by bursting; *Taylor* 1557, 1558.

COX, JAMES, Serjeant, R.A. (*Analysis of evidence.*)

Is staff serjeant of experimental department at Shoeburyness. The Armstrong gun the best he ever handled. No fear of its bursting. Is light, gives good range with great accuracy; easier to work than old 9-pr.; 415. Has trained men in half an hour to work the Armstrong gun who had never seen one before; 421. Could perfect the training of men in this drill in a fortnight; 424. With an untrained party fired five rounds from 110-pr. in six minutes some seconds; 426. Breaking of vent-pieces generally caused by using a charge larger than the usual one; 434. Breaking thread of breech screw not caused by discharge of the gun; has only occurred to small guns; 437, 438. Prefers breech loaders from greater facility of loading and safety; 442. There are guns which have fired 200 rounds without refacing vent-piece; 453. Has felt inconvenience from heat in old pattern vent-piece, not in the new with a handle; 454. By carelessness the vent-piece may be blown out; 465. From the complication of a breech loader it is more liable to injury than a muzzle loader from an enemy's fire, notwithstanding which, would prefer to have the former in the field; 467. For heavy guns would prefer the muzzle loader if equal in effect of fire to the breech loader; 471. Would rather have a breech loader in a casemate; 478. Considers the muzzle loader the quickest in working; 480. Requires to alter the position of gun when firing at high elevations; 482. No difficulty with the cups of the 110-pr.; 488. Has seen fired the Whit-



worth 12-pr. and 70-pr., the first of brass, the other of iron; 491. Great difficulty in getting the shot home in 70-pr.; 496. Cannot load with it as quick as a smooth bore, or a muzzle-loading rifle gun; 496. Got good practice with it, but thinks the 70-pr. Armstrong the best; 497. Range of Whitworth greater; 500. The difficulty of loading Whitworth is caused by the want of windage; 504. In loading the 12-pr. Whitworth of brass a shell jammed; 506. This gun gave good range; 521. Against iron plates the Whitworth has penetrated the most; 529. Has greater velocity and penetrating power; 535. Prefers the side-loading system to vent-piece; 539. With 70-pr. side loader 50 rounds were fired with good range in 32 minutes and 32 seconds; 540. Loss of time by depression of gun; 547. Has not seen projectiles permanently injured; 552. Whitworth shell not good; 559. Shunt 70-pr. equal for practice to the breech-loading 70-pr.; 569.

COX, SAMUEL, Master Gunner. (*Analysis of evidence.*)

Is master gunner at Shoeburyness, and previously serjeant instructor there; 225. Assisted at experiments at the time of the introduction of the Armstrong gun; 228. Considered that system a great improvement on the old; never before saw such ranges or precision. Does not remember accidents or injury to those working the guns; 233. No difficulty in instructing men in the drill. The fuzes and shells superior to those used before; 236. A good artilleryman should put the whole of his fire upon a column of companies at 3,000 yards; 237. Easy to instruct men in the use of fuzes; 238. Can in three weeks drill recruits to work a 12-pr. properly; 239. Considers No. 2 the only man of the gun detachment who could cause accident, by neglect of duty, from the vent-piece not being screwed up; 241. But with new vent-piece there would be no danger to the men; 247. But still to the breech screw; 250. Has seen old pattern vent-pieces blown out and broken; 251. Prefers having one kind of projectile to answer as shot, shell and case; 257. The thread of the breech screw at the end for two or three inches generally breaks off; 264. Has seldom noticed any choking of the vent; 273. If there was no oil to clean the breech screw, it could be taken out and cleaned in two or three minutes; 276. Tangent rings get loose after firing; 281. Has seldom known the keep pins of the tappet ring fall out; 282. Has no objection to, or alteration to suggest in, the Armstrong gun, and likes the breech-loading as well as the muzzle-loading system; 286. Considers there is a trifling difference in the rapidity of firing in favour of the muzzle-loading against the breech-loading rifle gun; 292. Prefers the Armstrong to the Whitworth gun, as its projectile is more destructive; 295. Considers the Armstrong gun, as made of wrought iron, is better than the Whitworth of brass, and from the quickness of twist in the Whitworth it is liable to damage, and the shot sticking in the bore, of which a case happened; 299-307. Has seen projectiles slightly damaged, but are easily rectified. Has not seen any projectile damaged by travelling; 308-323. The 12-pr. is easily dismantled; 326. Has seen 3,173 rounds fired from one gun now serviceable at Shoeburyness; no part was changed except the vent-piece; 329-333. Has known the vent-piece too hot for the men to handle in about 80 or 100 rounds; 336. Thinks the loosening of the copper ring on vent-piece the forerunner of the vent-piece breaking; 339. Considers the segment shell destructive at 3,000 yards with concussion fuze; 345. Has had no difficulty in working the heavier natures of Armstrong guns, and found them equal in accuracy to the smaller; 352. Has known lead strip off Armstrong 12-pr. shell so that it would be objectionable to fire over our own men; 359. The stripping does not interfere with the flight of the shot; 363. Sometimes there is a slight difficulty in lifting the vent-piece of a 110-pr., which may occur from the tin cup; 368. The heavier projectiles more liable to injury than the lighter ones; 372. The recoil of the shortened naval 20-pr. is very great; 380. 110-pr. Armstrong gun not fired quite so fast as 68-pr. smooth bore; 383. The wedge gun superior to the other, as dispensing with the screw; 390. Considers it beneficial to adapt the system to heavy guns only; 396. Wedge principle permits of quickest loading; 398. Considers vent-pieces for heavy guns weaker than those for light guns; 400. Believes that the projectiles coated by the tin process will become loosened; 410.

#### CRUTCH:

Witness remarks the want of a means of preventing the priming of the Armstrong gun before the vent-piece is in its place, and mentions a crutch designed for that object by Captain Singer, R.N.; *Liddell* 993.

#### CUPOLA:

Statement of experience in the management of the cupola, and result of using the 40 and 110-pr. Armstrong guns in them, and opinion that the breech-loading gun is best suited for their armament; *Liddell* 951. 973-976. 1053. 1090-1092; *Powell* 2317-2322. The possibility of carrying very large guns on board ship is effected by Captain Coles' cupola; *Hay* 1853, 1854; *Hewlett* 2086, 2087. From the confinement of space inside a cupola there would be a difficulty in loading a muzzle loader; *Powell* 2246-2249.

CUPS. See GAS.

#### D.

DEFECTS. See FLAWS.

#### DEFLECTION:

Evidence of the accurate correction for deflection which may be made with the Armstrong gun; *Milman* 730, 731. Statement extracted from Major Hay's report, that the men paid little attention to accuracy in adjusting for deflection in the expedition to China; *Gardner* 2656. The deflection with Armstrong projectile greater than with the Whitworth shrapnel with taper; *Boxer* 1570, 1571.

DESBOROUGH, JOHN, Lieut.-Colonel, R.A. (*Analysis of evidence.*)

Commanded a division of artillery in China. Considers the effect of the common shell from 24-pr. howitzers was superior to the fire from 12-pr. Armstrong, as proved by the silencing the fire of two Chinese junks at 500 yards; 1447. Would arm field batteries with some shell guns on the Armstrong principle; 1450. Is of opinion that the Armstrong gun was not sufficiently tried in China to form an opinion upon its merits; 1456. Does not think the machinery of the breech loading caused the men to be flurried under a hot fire from the Taku forts; 1462. Would prefer muzzle loaders; 1463. From what has been said of the shortened 20-pr. Armstrong, would prefer it to the 24-pr. howitzer smooth bore as a shell gun; 1466. Mentions the report of men of the 44th Regiment having been injured by Armstrong shell fragments; 1471. The guns were not roughly used; 1476. The wagons were heavy; they were experimental; 1477.

DESTRUCTIVE EFFECTS. See FIRE, SHELL.

#### DISMOUNTING:

Method used in dismantling 12-pr. Armstrong gun; *Cox*, S. 324-326. Evidence of the necessity of having a lip under the muzzle of guns on board ship for safety in dismantling; *Liddell* 1067.

#### DRILL AND EASE OF WORKING:

Evidence generally as to the ease of drilling with and working the Armstrong gun; *Cox*, S. 232. 234. 238. 239. 352. 364; *Cox*, J. 419-426; *Milman* 780-782; *Liddell* 1036; *Milward* 1344; *Hewlett* 2132. 2183; *Powell* 2285; *Gardner* 2604. Complaints as to the difficulty of working 110-pr. Armstrong gun; *Milman* 787, 788; *Gardner* 2638. 2665. Statements that it is easier to work the 68-pr. smooth bore than the 110-pr. Armstrong; *Cox*, S. 383; *Alderson* 648; *Milman* 804; *Rice* 1911. 1919. Witness states that the wedge system works easier than 110-pr. Armstrong. That the breech-loading heavy guns are more laborious than the muzzle-loading heavy guns. There is greater ease in working the shunt 120-pr. than the breech-loading 110-pr. Armstrong; *Milman* 796. 801. 814. Witness observes that the 110-pr. is as easily worked as the 68-pr. with the exception of loading and firing; *Bechervaise* 1209. Statement of the difficulty found by the witness in working an Armstrong 12-pr. breech-loading gun; *Boxer* 1623, 1624. Witnesses state that the heavy smooth bore is quicker in serving than the heavy breech loader; *Cox*, J. 526; *Powell* 2243. Evidence that it takes longer to train men to the breech-loading than to the muzzle-loading system; *Gardner* 2728. Statement made of no difficulty being found in working the vent-piece of the

110-pr. Armstrong, as it only required men of a certain height; *Powell* 2289; *Hewlett* 2082. Witness mentions the difficulty in loading the 70-pr. Whitworth gun; *Cox*, *J.* 495, 496. The Whitworth brass 12-pr. equalled in facility of working the Armstrong gun; *Alderson* 624. Difficulty in loading the Whitworth gun; *Hewlett* 2052, 2072. Evidence given as to a case in which a Whitworth gun became damaged in the bore and caused a difficulty in loading; *Cox*, *S.* 301, 306; *Cox*, *J.* 506; *Alderson* 619; *Taylor* 1498-1500. Evidence that four 12-pr. brass Whitworth guns were worked very easily at Hythe; *Isacke* 2804. Statement of witness that there is not any material difference in the ease of working the Armstrong and Whitworth 12-pr. guns, but of the two the Whitworth is the quickest and has least work for the detachment; *Best* 2949. Evidence that the first Whitworth guns made had too little windage, and caused the shot to stick; *Whitworth* 84. Opinion that if sufficient windage is given that the Whitworth projectile will not stick in the bore; *Boyer* 1614.

## E.

EFFECT OF FIRE. See FIRE.

## 80-PR. WHITWORTH GUN:

Evidence of the 80-pr. Whitworth gun becoming unserviceable from splitting or bursting; *Gordon* 1760; *Hewlett* 2068, 2069.

## ENDURANCE:

Evidence considers the wrought-iron Armstrong gun more durable than the Whitworth brass gun, and states that the greatest number of rounds that he has known fired from an Armstrong 12-pr. was 3,173; *Cox*, *S.* 299, 329. Witness states that one 12-pr. Armstrong gun fired 3,000 rounds, and was still serviceable; *Milman* 861. Evidence observes that 2,400 rounds were fired from a 12-pr. Armstrong from the "Excellent," and believes that the breech-loading Armstrong guns are capable of enduring the roughest service; *Liddell* 954, 1062, 1064. Witness states that the guns under his command endured much rough work in China without injury; *Milward* 1365. Instance given of the endurance shown by some Armstrong guns in not being injured by being precipitated into a ditch; *Alderson* 696-698; *Taylor* 1491. Evidence of Armstrong guns having endured 3,000 rounds without injury, and a statement of belief that there is one gun which is still sound and has fired about 3,600 rounds; *Taylor* 1552, 1553. Opinion as to the importance of enduring powers in a rifle gun; *Hay* 1832, 1834, 1835. Witness states you may treat the Armstrong guns as roughly as any guns in the service, and thinks that one 40-pr. Armstrong endured 1,000 rounds and was perfectly serviceable; *Hewlett* 2113, 2147, 2148. Opinions that the Armstrong guns were unfitted to stand the rough usage of the service; *Glyn* 1947; *Seymour* 2000; *Gardner* 2609, 2645, 2672, 2685. Witness is of opinion that a gun rifled on the Whitworth principle is capable of as much endurance as an Armstrong gun; *Boyer* 1657. Opinion that although the Whitworth gun has a great deal of work to do, from the rapidity of its twist and length of projectile, yet it is equal to the strain; *Anderson* 3181-3183.

## EXPENSE:

Expense of shaping the 12-pr. Whitworth shot, 5*d.* per dozen; *Whitworth* 54, 4026. Statement of expense of 12-pr. Armstrong segment shell with burster and concussion fuze to be 6*s.*; *Armstrong* 153-155. Witness states that the cost of the Whitworth projectiles is less than those for the Armstrong gun if the same iron be used, and gives the prices of Armstrong and Whitworth 40-pr. projectiles; *Boyer* 1666, 1667. Cost of reloading Armstrong projectiles become unserviceable from being coated by the tin process, 10*l.* per 100; *ib.* 1740. Evidence of the expensive nature of the 'proof' requisite for vent-pieces; *Gordon* 1776. Statement that the expense estimated for 364 12-pr. Armstrongs was 200*l.* a piece, and that they were done for 83*l.*; *Anderson* 2374. Opinion that coil guns are not very expensive, but that solid forged guns would be cheaper; *Anderson* 2431, 2432. Evidence that the addition of steel barrels to Armstrong guns would not add much to the expense; *Armstrong* 133. Statement that the cost mentioned of Armstrong guns includes the guns rejected at proof; *Anderson* 2967. Cost of the metal

for the manufacture of the Whitworth gun, 60*l.* to 90*l.* per ton, according to the size of the barrel required for the gun; *Whitworth* 3779-3783. By the hardening and tempering process the metal may sometimes be improved in value 50 per cent.; *ib.* 3800. The finished Whitworth 12-pr. is four times the expense of the material required to make it; *ib.* 3804-3807. Opinion that the cost of a projectile is more important than that of the gun; *ib.* 3810, 3811. Probability of the cost of steel coming down to 30*l.* per ton, and statement of the price of Bessemer steel to be now from 30*l.* to 40*l.* per ton; *ib.* 3813, 3814. The cost of the Whitworth gun as made from steel will always be more than the wrought-iron gun from the expensive nature of the material; *ib.* 3836; *Noble* 3427. As a question of economy there is no system so cheap as the polygonal when taken in connexion with the projectiles; *Whitworth* 4094-4097. Mention of the price of the 70-pr. Whitworth at 500*l.*; *ib.* 4131. Evidence of the cost of the steel barrels for Armstrong guns from 70*l.* to 120*l.* per ton according to the size of the barrel; *Noble* 3267. Cost of Bessemer steel for barrels would be about 50*l.* to 60*l.* per ton; *ib.* 3292. The value of the barrel when turned and bored would be 50 per cent. more than the original cost; *ib.* 3310, 3412-3427. The difference in the cost of coiled barrel and steel considerable; *ib.* 3404-3408. Statement of price of experimental 12-prs. as 254*l.* for the breech loader, and 226*l.* for the muzzle loader; the former cost of 12-pr. breech loader, 90*l.*; *ib.* 3437-3441. Evidence that Mr. Whitworth's price for 300-pr. is 3,000*l.*, while that gun is supplied by the Armstrong firm at 1,620*l.*, and opinion that it stands to reason the cost of the Armstrong should be the least, the material in it costing 20*l.* per ton against that for the other being 80*l.* per ton; *ib.* 3443. Cost of welding and working up wrought iron into coiled cylinders adds 50 per cent. on the value of the material; *ib.* 3454. The cost of the wrought iron now used in the gun factories for coils is from 12*l.* to 14*l.* per ton; and if found to answer will cheapen very much the manufacture of the Armstrong gun; *ib.* 3457. Mention of the cost of the finished barrel for 70-pr. Armstrong as 210*l.*, or three times the cost of the raw material; *ib.* 3594. Any system of rifling adds little to the cost of a gun; *ib.* 3607. The breech and muzzle-loading Armstrong 70-pr. quoted at the same price, the former being the lightest by about 15 cwt.; but as a rule the breech-loading apparatus is most expensive; *ib.* 3616-3619. The cost of the same kind of projectiles as supplied to the Committee would come to 25 to 30 per cent. less if supplied in large quantities; *ib.* 3626. The cost of tools to accompany 12-pr. Armstrong guns stated at 10*l.* to 12*l.* per set; *ib.* 3649. Instance of cost of 12-pr. segment shell as 2*s.* 10*d.* when supplied to the British Government. The charge to the Committee 4*s.* for segment shell, 3*s.* 6*d.* for common shell; cost of a time fuze, 2*s.* 6*d.* to 2*s.*; concussion fuze, 1*s.*; pillar fuze, 1*s.* 10*d.*; and an adapter, 6*d.*; *ib.* 3670-3679. Statement that experimental guns are high in price from requiring special tools for their manufacture; the tools for the first 600-pr. costing 800*l.*; *ib.* 3687. The cost of the first 110-pr. shell was 23*s.* 6*d.* each; they were afterwards supplied for 13*s.* each; *ib.* 3689. The steel makers charge 130*l.* per ton for the barrel for 600-pr., or 600*l.* for the whole; *ib.* 3691, 3707. Cost of the steel ingot for 300-pr. barrel is 300*l.*, for the 150-pr. it is 180*l.*; *ib.* 3696, 3707. Tabular statement of the cost of the Armstrong and Whitworth ordnance and projectiles; *App.* 159-161. Cost of the special tools for Armstrong guns; *App.* 164. Cost of alterations and repair to Armstrong guns as far as is known at Woolwich; *App.* 167-200.

## EXPERIMENTS:

Evidence of experiments at Shoeburyness for testing the rapidity of fire between Armstrong, Whitworth, and other guns; *Whitworth* 97-101; *Alderson* 625; *Taylor* 1480-1484. Experiments of the Select Committee to determine penetration into earthwork, masonry, and wood; *Taylor* 1547-1550; *App.* 158. Experiments in connexion with Captain Coles's cupola shield; *Liddell* 973-985; *Powell* 2299-2306, 2314-2326. Experiments to determine the strength necessary for breeching ropes for Armstrong broad-side guns; *Liddell* 1159-1166. Experiments carried on against iron plates; *Harrison*, *A.* 1404-1444. (See Analysis of his evidence.) Experiments to determine the best form for the Whitworth shrapnel shell;



*Boxer* 1570-1576. 1613-1615. Result of experiments with flat-headed projectiles; *Boxer* 1617, 1618, 1735; *Hay* 1859-1862. Evidence of submarine experiments; *Liddell* 1075-1087; *Hewlett* 2165-2181. Evidence of the experiments for ascertaining the torsional strain on different rifle barrels; *Hay* 1836; *Anderson* 2480-2483. Experiments between Armstrong and Whitworth 12-pr. guns at Shorncliffe; *Isacke* 2799-2867; *Best* 2868-2965.

Programme of experiments with field guns to be carried on by Armstrong and Whitworth Committee; *App.* 165.

#### COMPETITIVE EXPERIMENTS BEFORE COMMITTEE.

##### 12-pr. breech-loading Armstrong gun.

|                                                                                                                     | Appendix. |
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| Experiments for range and accuracy - -                                                                              | 252-261   |
| " for target practice - -                                                                                           | 262-265   |
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| " destructive effects of segment shell against targets - -                                                          | 271-281   |
| " with fuzes - - -                                                                                                  | 282       |
| " rough usage, and effect of premature bursting in the bore -                                                       | 283       |
| " rapid firing - - -                                                                                                | 284       |
| " Sir W. Armstrong's programme, with zincd and undercut projectiles, fuzes, and rapid firing sea service trials - - | 285-288   |
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##### 12-pr. Whitworth gun.

|                                                                                |         |
|--------------------------------------------------------------------------------|---------|
| Experiments for range and accuracy - -                                         | 291-302 |
| " target practice - - -                                                        | 303-306 |
| " against earthworks and abattis -                                             | 307     |
| " stockades, walls, field artillery, and rope mantlets - -                     | 308     |
| " destructive effect of Boxer's shrapnel shell - -                             | 309     |
| " destructive effect of Whitworth common case - - -                            | 310     |
| " Boxer's shrapnel shell against targets representing troops in position - - - | 312-324 |
| " with fuzes - - -                                                             | 325     |
| " rough usage and premature bursting of shell - -                              | 326     |
| " rapid firing - - -                                                           | 327     |
| " Mr. Whitworth's programme, rifled spheres, shot, and submarine practice - -  | 328-331 |
| " sea service trials - - -                                                     | 332     |

##### 12-pr. muzzle-loading Armstrong gun.

|                                                                                      |         |
|--------------------------------------------------------------------------------------|---------|
| Experiments for range and accuracy - -                                               | 333-344 |
| " target practice - - -                                                              | 345-348 |
| " against earthworks and abattis -                                                   | 349     |
| " stockades, walls, field artillery, and rope mantlets - -                           | 350     |
| " destructive effects of segment shell as common case - -                            | 351     |
| " Lieut. Reeve's common case -                                                       | 352     |
| " destructive effects against targets representing troops -                          | 354-363 |
| " with fuzes - - -                                                                   | 364     |
| " rough usage and effect of premature bursting of shell in the bore - - -            | 365     |
| " rapid firing - - -                                                                 | 366     |
| " sea service trials - - -                                                           | 367     |
| " initial velocity and retardation angles of descent of solid shot from 12-pr. - - - | 368-371 |
|                                                                                      | 372     |

#### EXTRACTOR:

Evidence of the necessity of having an extractor for removing the metal cartridge case in the Whitworth gun; *Whitworth* 95. 100; *Taylor* 1482.

#### F.

#### FACING OF ARMSTRONG GUNS AND BUSHING:

Evidence that where facing is used no copper cap is required, and states that wear in large guns is the cause of objection to their being faced; *Armstrong* 218, 219. Witness has never seen gunners sufficiently

instructed to enable them to face a gun without assistance; *Coz*, S. 348. Statement that some guns at Shorncliffe have fired 200 rounds before being refaced; *Coz*, J. 453. Observation that the necessity for facing varies according to the hardness of the copper, and that 250 would be the mean number of rounds before facing would be required. The lowest number would be 150; does not think facing any practical disadvantage, and any ordinary man can be trained to face in a couple of days; *Milman* 865-900. Witness does not see any difficulty in facing. Gives 150 rounds as the mean for refacing; *Liddell* 1043-1049. Evidence has found no difficulty in facing the copper ring in the chamber of the gun, but has found it difficult to face the vent-piece; *Bechervaise* 1267-1271. Witness states that he found no necessity to renew the bushing of his guns, but had faced them once, and had fired only 200 rounds; *Milward* 1392. Evidence states that the necessity of refacing the Armstrong guns does not weigh with him against the use of these guns; *Taylor* 1490. Witness gives an instance of the difficulty in supplying the proper pattern bouche rings for 110-pr. Armstrongs, and gives evidence of the complicated nature of the facing tools; *Gordon* 1756, 1757. 1797-1807. Evidence states that guns in the "Excellent" are refaced after 200 or 300 rounds (more or less), but some guns fire 600 or 700 without requiring it. Finds no difficulty in the operation; *Hewlett* 2145, 2146. Witness considers the copper bushing on the vent-piece and in the bore is very objectionable; *Anderson* 2514.

#### FAILURES. See FLAWS.

#### FIRE, THE EFFECT OF:

Statement that an artilleryman ought to put the whole of his fire from an Armstrong gun into a column of companies 3,000 yards distant; *Coz*, S. 237. 344, 345. Statement of the effect of fire of Armstrong's segment shell at 100 and 300 yards, and the dispersion of fragments from these projectiles; *Alderson* 604, 627. Opinion that at 3,000 yards range nearly the whole of the fire from an Armstrong gun should be delivered on a front of 50 yards, and out of 20 rounds a competent gunner should hit a six foot target 14 or 15 shots out of 20, and mentions a case of accurate firing; *Milman* 728, 729. 757, 761. Effect of the fire of Armstrong 12-pr. in China; *Milward* 1317-1322. 1333-1343. 1353-1358. 1383-1385. 1397; *Desborough* 1447. 1455. 1457-1459. 1464, 1465; *Harrison*, R. 1865-1868. 1875. 1880-1885. Evidence of the want of success in the firing the 12-pr. Armstrongs in New Zealand; *Seymour* 1993. 1995, 1996. Evidence as to the rapidity of fire possible with Armstrong guns. Fired five rounds in six minutes and a few seconds with 110-pr. With 70-pr. wedge gun fired 50 rounds in 32 minutes 32 seconds. Has seen 70 or 80 rounds fired from a 12-pr. in one day; *Coz*, J. 426. 540. 549, 550. Average time to fire five rounds from a 12-pr. was 3 minutes 40 or 50 seconds. With all detachments it would be about a round per minute; *Milman* 819, 820. 824. Rapidity of fire of Armstrong breech loaders is very great, except the 110-pr. Shortest time of firing six rounds in the "Excellent" is 3 minutes 45 seconds. From Captain Coles' cupola fired six rounds in 2 minutes 40 seconds. Fired from 40-pr. 100 rounds in 86 minutes; *Liddell* 1028. 1030. 1032. 1172. Evidence that the rapidity of the fire from Armstrong guns is sufficiently great; *Milward* 1363. Several instances of the rapidity of fire; *Taylor* 1542. The breech loader capable of more firing than the muzzle loader; *Hewlett* 2154. 2214. Evidence as to the rapidity of fire of the muzzle loader over the breech loader; *Coz*, S. 292. 383; *Coz*, J. 480; *Powell* 2285; *Gardner* 2606. The Armstrong wedge guns quicker in fire than the screw breech loader; *Coz*, J. 398. 540. The effect of fire from smooth-bore field guns more effective than from Armstrong 12-prs. when the men are hurried; *Gardner* 2701. The ranges of Armstrong and Whitworth guns about the same with equal charges; *Alderson* 707. Instance given of the rapidity of the fire from a Whitworth gun being about the same as a smooth bore, and a comparison of the rapidity between Armstrong and Whitworth guns at Shorncliffe; *Whitworth* 97-102; *Isacke* 2807. Statement of the irregular fire obtained from some Whitworth guns; *Best* 2901. 2903. Evidence that on the first trial between the Armstrong and Whitworth breech loaders that the Armstrong had the advantage of rapidity of fire,

but since the Whitworth muzzle loader has been introduced its speed is greater than Armstrong; *Taylor* 1481. 1485. Effect of ricochet fire bad with elongated shell, but with a suitable concussion fuze it would be well adapted for plunging fire; *Alderson* 680-682; *Hewlett* 2149; *Powell* 2307.

FLAT-HEADED PROJECTILES. See PROJECTILES.

#### FLAWS AND DEFECTS:

Witness observes the liability to internal flaws in steel barrels increases as the size of the barrel enlarges. In the early manufacture of the Armstrong gun it was a matter of difficulty to make perfect welds and turn out guns free from defects; *Armstrong* 126. 134. Opinion that the breech screws become injured from flaws; *Alderson* 588, 602. Witness states his readiness to furnish returns showing the number of Armstrong guns returned for defects, and observes that it would not be a satisfactory criterion of the proportion of guns which have become defective, as three-fourths of those issued have not been fired; *Gordon* 1748, 1749; *App.* 167-200. Evidence that in the early experiments with Armstrong guns flaws in the rifling were thought of more importance than they are now; *Hewlett* 2049. Statement of a preference for the Whitworth gun, as so many of the Armstrongs had burst, cracked, and gone in different ways; *Best* 2952. Witness states that to get an Armstrong gun free from defects inside it is requisite to have a pure iron; *Anderson* 2351. The longitudinal direction of the fibre in the solid forged barrels the cause of scorings in the bores of Armstrong guns; *ib.* 2358, 2459, 2460. Statement of the necessity of renewing the barrels of 160 12-prs. out of 360 in consequence of defects in the welding of their coiled barrels; *ib.* 2366-2368. Evidence that the defects in large forgings are always to be found near the centre; *ib.* 2441. Explanation of the defects of construction of the Armstrong 300-pr.; *ib.* 2488. Evidence of the flaws discovered in the 150-pr. before bursting; *ib.* 2496-2498. Statement of having seen coils separating, and is therefore inclined to prefer a solid gun; *Gardner* 2718. Evidence of the per-centage of failures from defects in Armstrong guns; *Anderson* 2967. Explanation that the 25 per cent. of failures from defects related merely to the inner barrels; *ib.* 3104. Failures in the outer coils not of serious importance; *ib.* 3109. Longitudinal fracture of 12-pr. gun at Shorncliffe can only be accounted for by the breech piece being imperfectly welded; *ib.* 3110, 3111. Report of the flaws found in four brass 12-pr. Whitworth guns after 200 rounds; *App.* 165. Evidence of a flaw in the bore of a brass Whitworth at Shorncliffe; *Cox, S.* 303; *Alderson* 619; *Taylor* 1500. Statement that the Armstrong guns submitted to the Committee have the material applied in a manner which best ensures the detection of dangerous flaws. *Letter of Sir. W. Armstrong, App.* 155. The flaws and defects in steel barrels considerable; *Noble* 3235-3246. 3328, 3329. Statement of the failures of the steel Whitworth guns made for the Viceroy of Egypt and the Government at Copenhagen, the damage done, and lives lost; *ib.* 3466-3470. 3517. Denial of the failures of the guns supplied by Mr. Whitworth to the Pasha of Egypt; *Whitworth* 3877-3886.

#### FORGINGS:

Mention made of the importance of introducing a barrel or inner tube into the Armstrong guns made from a solid mass of steel or homogeneous metal, and great difficulty has been found in obtaining this metal free from imperfections, and in consequence recourse has been had to wrought iron in coils, and also solid forgings bored out. But from the perfection attained up to the present, in the manufacture of steel, it is hoped the difficulties will be surmounted, as barrels made of the coil principle are often defective from imperfect welds, and also those of solid forged iron; *Armstrong* 123-125. 129-134. 137, 138. 204-206; *Anderson* 2407-2409. 2412-2414. 2418-2422. 2966. 2968, 2969. 3137; *Noble* 3235-3246. 3340-3353. 3476-3478. Witness states that out of 2,500 built up guns, he has made between 600 and 700 with a core on the solid plan, which is not nearly perfect, but considers it better than the coiled barrel; *Anderson* 2353. 2360. 2390. 2394. 2966. A large forging will not answer for guns from the imperfections which will be found in the centre; *ib.* 2382. 2436. 2439. 2441; *Noble* 3527-3529. Statement of the construction of the

breech piece of a solid forging, and the difficulties met with in attaining perfect soundness, and alleged superiority of the solid forged breech piece over the first method used in its construction; *Armstrong* 125; *Anderson* 2385-2389. 2433. Evidence that all trunnion pieces for Armstrong guns are made from solid forgings; *Anderson* 3125, 3126. Welds in the coils have only about 50 or 60 per cent. the strength of the original bar of wrought iron; *Noble* 3356.

#### 40-PR. ARMSTRONG GUN:

The 40-pr. proposed as a gun of position, and statement that witness would adhere to the existing construction of that gun; *Armstrong* 120. 127. Preference for the 40-pr. for siege purposes and on board ship, and general approval of that gun and its performance; *Alderson* 645. 690; *Milman* 787. 856. 857; *Liddell* 951. 974. 1004. 1037. 1091. 1159. 1163. 1172. 1176; *Bechervaise* 1207. 1274; *Hay* 1834. 1843; *Rice* 1935; *Hewlett* 2071; *Powell* 2319; *Gardner* 2634. 2749. Per-centage of failures during manufacture of the 40-prs.; *Anderson* 2967.

#### FOULING:

Witness mentions the necessity of water or oil to prevent fouling of the breech screw in Armstrong guns; *Cox, S.* 269; *Gardner* 2634. Statement that the introduction of the lubricator prevents fouling; *Cox, J.* 565. 575; *Alderson* 654; *Liddell* 1167, 1168. Witness states 100 rounds were fired from the Whitworth guns at Shorncliffe, and that washing out the bores was not done, although no lubricator was used, and opinion that to require lubrication is a defect in a system; *Whitworth* 83; *Boxer* 1578, 1579. Complaint of the fouling experienced with a 12-pr. Armstrong gun; *Boxer* 1633-1640. Complaint of the fouling in the Whitworth gun; *Hewlett* 2058. 2072, 2073. 2100. 2199.

#### FRICTION:

In the Whitworth gun the action of the gas wears the gun more than the friction of shot; *Whitworth* 103, 104; *Boxer* 1658. The forcing action in the Armstrong shot is not a continued friction all through the bore, but merely in the first movement; *Armstrong* 173. Importance of a soft metal coating on rifle projectiles to diminish friction; *Hay* 1836. 1838. 1843, 1849; *Hewlett* 2076. 2093. 2190. Witness is of opinion that the friction of a rifle projectile will not wear out a gun as long as there is plenty of bearing surface, and that there is enough of that for safety in both Armstrong and Whitworth guns, and considers the friction of hard metal projectiles is of no injury to the bore, would therefore prefer such projectiles, as those covered with soft metal deteriorate; witness, however, makes an exception to the above when shown a projectile fired from a brass Whitworth; *Anderson* 2472-2476. 3002. 3142-3144.

#### FUEL:

The importance of using fuel without impurities, such as sulphur and iron pyrites, in forging the Armstrong gun, and the care used to select the best Hartley coal; *Anderson* 2337. 3107, 3108.

#### FUZE:

In the Whitworth projectiles the common fuze of the service may be used, which is lighted by the flame of the discharge, and opinions that it is advantageous so to light a fuze; *Whitworth* 49, 50. 75; *Boxer* 1578; *Taylor* 1539; *Hewlett* 2195. Witness states that the common fuze of the service may be made available by the addition of a detonating arrangement; *Boxer* 1704. Opinion that if the Boxer fuze could be made available with Armstrong shells that it would be an advantage; *Gardner* 2733-2735. Evidence in approval of the new pattern Armstrong time and concussion fuze; *Armstrong* 161; *Cox, S.* 236-238. 260; *Alderson* 659, 660. 710; *Milman* 919, 920. 925; *Liddell* 1020; *Taylor* 1545; *Gardner* 2654. The premature bursting of some shells attributed to using the old pattern time fuze in combination with the new pattern concussion fuzes; *Armstrong* 139. The old pattern time fuze defective; *Armstrong* 161; *Milman* 921. 924; *Liddell* 1015-1018; *Bechervaise* 1291; *Milward* 1316; *Taylor* 1545; *Boxer* 1720; *Hewlett* 2122, 2123. Evidence as to the complication of the Armstrong fuze, and the probability of their not succeeding on service, and statement that the concussion fuze is not of much use; *Boxer* 1705-1707. 1710-1723; *Glyn* 1977. 1978; *Gardner* 2619. 2653. Opinion in favour of the Armstrong time



fuze from the facility of altering it when in shell; *Hewlett* 2218; *Powell* 2312. Experience favourable to the Armstrong fuzes; *Rice* 1924, 1925; *Powell* 2309, 2310. Statement of the advantage of having the time and concussion fuze in each shell; *Milman* 846; *Gardner* 2698. Statement made that the Moorsom composition does not deteriorate, and that it has been made use of in the manufacture of Armstrong pillar fuzes; *Boxer* 1729; *Gordon* 1826. Evidence in approval of the Armstrong pillar fuze; *Alderson* 720; *Milman* 929; *Hewlett* 2122, 2174, 2175; *Gardner* 2714-2716. Evidence that the pillar fuze is liable to accidents, and is considered too delicate, and statement of the accident in the store department, Woolwich, by the firing of a pillar fuze; *Boxer* 1725; *Gordon* 1812-8115; *Bent* 2759-2761. Recommendation not to screw the pillar fuzes into the shells until just wanted for firing; *Bent* 2760. Evidence of the accident on board the "Stork" from the premature firing of a time fuze; *Liddell* 1018. Statement that the fuze adapter is an advantage, and thinks that all fuzes should be of the same gauge; *Milman* 933, 934. Opinion that in consequence of the thread of the adapter being in an opposite direction to that of the fuze, that the latter drops out in the flight of the projectile; *Bechervaise* 1292, 1293. Evidence given as to the want felt for a fuze sufficiently sensitive for parapet firing with small charges; *Alderson* 684; *Liddell* 1020; *Hewlett* 2151; *Gardner* 2753. Success of the Armstrong concussion fuze in China against cavalry and also against parapets, owing to the thin nature of the latter; *Milward* 1317, 1338. Evidence that it was found in firing shell against iron plates, that fuzes were not required to fire the shell; *Harrison*, A. 1442, 1443. Evidence, that the Whitworth firm have now commenced to make their own fuzes on a similar plan to the Boxer fuze; *Whitworth* 4031-4034. Competitive experiments of fuzes with 12-pr. breech-loading Armstrong; *App.* 282, 288; with 12-pr. Whitworth; *App.*, 325; with 12-pr. muzzle-loading Armstrong; *App.*, 364.

#### G.

GARDNER, WILLIAM B., Colonel R.A. (*Analysis of evidence.*)

Is the chief instructor at Shoeburyness; has seen some practice with Whitworth guns, but with Armstrong fired about 600 rounds from the 12, 20, 40, and 110-prs. The 12-pr. has a good range and is remarkably accurate; 2603. The smaller calibre of this gun work easily; 2604. Prefers muzzle loaders for the field, but under cover and in casemates, and perhaps on board ship, breech loaders might be most useful; 2605. Muzzle loader best for rapid firing; 2606. Armstrong gun not adapted for firing molten iron, 2608. Does not consider 12-pr. a good gun for rough work, the breech-loading principle is superfluous in a field gun; 2611. Believes that the larger the calibre the greater the difficulty with the breech-loading apparatus; 2612. Thinks that the side-loading gun would be more easily worked than the breech loader; 2613. Does not think that 110-prs. are fit for coast defences against iron-clads; 2614. There is a very great want of a common shell for field guns; 2616. Rather inclined to keep the shell guns in distinct batteries; 2618. Considers the fuzes too complicated to act well; 2619. The number of tools carried by an Armstrong field battery an objection, would prefer a hard surface to projectiles if possible to make it very simple; 2626. Was told the projectiles suffered much in the limber boxes in Canada; 2627. The difficulty in working 110-pr. lies in the breech screw, lifting the vent-piece, and putting the shot in. The tin cups also cause a complication; 2638. Has known the vent-piece jam and break during firing; 2640. Colonel Barry says in his report on the guns in China, on one occasion the breech screws became jammed with rust; should consider that enough to condemn the guns. One of the vent-pieces was blown out; Major Hay states two vent-pieces were blown out, although assured by the men that the breech screw was properly screwed up, and the vent-pieces became so hot that it was difficult to hold them. Would not undertake to say that the new pattern vent piece would not blow out; 2645. If sand were to get on the breech screws they would not work; 2649. Considers the segment shell very formidable; 2651. Or. the whole the Armstrong projectiles are good; 2652. Believes india-rubber would

become injured in the time fuzes; 2653. New concussion fuzes act well; 2654. The system of sighting too complicated; 2656. Has seen about 18 accidents with the vent-pieces of all patterns, but never saw anyone injured by them; 2659. Men learn the drill easily with smaller natures of Armstrong gun, but not with 110-pr.; 2665. Trained artificers necessary for repairs to these guns; 2667. Oil very necessary to the working of breech screws; 2672. Strongly against breech loaders; 2679. Knew of three cases where guns had to be sent for repair, could not continue firing; 2685. Dangerous to touch a shell when stuck in the bore of a rifle gun; 2689. Considers it an advantage to have a time and concussion fuze to each shell; 2698. Found that at 800 yards with 9-pr. gun, and 24-pr. howitzer, that rather better practice was made by them than with 12-pr. Armstrong, the firing being quick and hurried in both cases; 2701. For sea defences, if it be a question of point blank range, would prefer the 68-pr. gun, or a large smooth bore, but not for a long range; 2704. Considers the "pillar" a formidable fuze; 2716. Considers coil system advantageous, as giving warning of its breaking up, but would prefer a solid gun if it could be made; 2718. A very great advantage to have one kind of projectile; 2721. Believes penetration a question of the material in the projectile; 2724. Takes longer to train men to breech-loading system than to the muzzle-loading; 2728. Would recommend batteries in the proportion of half rifled, and half smooth bore, 2730. Considers the Whitworth a wonderfully accurate gun; 2732. Would prefer the Boxer fuze if it could be used with the Armstrong projectile; 2733. Rifle guns immense advantage in sieges; 2748. A more sensitive concussion fuze required for enfilading fire with Armstrong guns; 2753.

#### GAS, ESCAPE OF:

Evidence that on the first trials of the Armstrong wedge gun that the escape of gas was considerable, but by the alterations introduced it was entirely obviated; *Armstrong* 126; *Cox*, S. 395; *Hewlett* 2078. Opinion given of the difficulty of securing the wedge gun from allowing of an escape of gas; *Anderson* 2565-2568. Evidence given that on board the "Excellent" it is considered best to reface after 150 rounds, because it is inconvenient to have an escape of gas, and an instance given of a considerable escape on one occasion; *Liddell* 1045, 1047, 1060. Statement that gas escape in Armstrong guns fouls the breech screw, and that all these guns are more or less liable to it; *Boxer* 1625, 1626. Evidence that although the vent-piece with projecting back would not be blown out, yet the escape of gas may be very great unless the breech screw is properly screwed up; *Hewlett* 2141. Witness gives an instance of an officer being singed by the escape of gas from a 40-pr. Armstrong; *Powell* 2253. Evidence of the difficulties met with in the use of the tin cups with the 110-pr. Armstrong to prevent the escape of gas, and instances given of their being the cause of jamming the vent-pieces; *Cox*, S. 368; *Alderson* 656; *Milman* 828, 830, 903-905; *Liddell* 1008-1014; *Bechervaise* 1209-1212; *Boxer* 1626; *Powell* 2294; *Gardner* 2638, 2639.

#### GAUGES:

Statement of the accuracy of dimensions attainable in the manufacture of projectiles in the Royal Laboratory, and of the necessity of a limit between high and low gauge being allowed, and information given that a considerable number of Armstrong shells sent to the Laboratory to be reloaded have their fuze holes out of the proper centre line; *Boxer* 1649-1651, 1676-1678. The importance of great accuracy of gauge in the tools used in the repair of Armstrong guns, and that no makeshift could be successfully employed to replace them; *Anderson* 2553, 2554. The necessity of great care in gauging the coils of the Armstrong gun to allow of the proper tension when shrunk on, and account of the accuracy with which it is done; *ib.* 3077-3079. Evidence of the labour entailed in gauging any Armstrong projectiles which have been moved about at all, from the alteration of shape in the soft metal to which they are liable; *Bent* 2779-2781.

#### GEAR AND TOOLS:

Witnesses complain of the inconvenience of carrying with Armstrong guns so much gear and tools; *Bechervaise* 1306; *Seymour* 2000; *Anderson* 2552; *Gardner*



2621. Evidence contends that the advantages gained by the Armstrong system are sufficient to counterbalance the inconvenience of carrying so many tools; *Taylor* 1490. Statement of the complicated nature of the tools necessary for Armstrong guns, and the difficulty of keeping the store supply correct, in consequence of the frequent changes of patterns. Mention made of the spare stores which will probably be required by these guns on issue; *Gordon* 1756-1759, 1764-1768, 1794, 1799, 1805, 1809. Evidence of the great accuracy required in the work to be performed by the tools to accompany Armstrong guns, and for the larger guns the tools to be carried are most formidable. It would be impossible to replace these tools if lost in the field. The tools required for the repair of the wedge Armstrong guns will require great exactness, as the repair of those guns is an operation requiring great care; *Anderson* 2552-2565. Returns of facing tools, spare articles, and implements for the use of the armourers detailed for the repair of Armstrong guns; *App.* 162-164. Evidence of the cost of the tools to accompany breech-loading Armstrong guns; *Noble* 3648-3650.

GLYN, HENRY C., Captain R.N. (*Analysis of evidence.*)

Has been on active service in New Zealand with the light 12-pr. Armstrong gun for boat service; it was useless, first, from its being too long, from the motion in the boat, and not fit for rough handling in landing on a beach. Applied for 12-pr. howitzer to supersede it; 1947. Considers a muzzle loader the best for boat service; 1955. Has no complaint against the ammunition, except some stripping of lead from shells; 1971. In manning boats one description of projectiles advantageous; 1975. Found that when men were flurried that the fuzes did not act well at short ranges; 1977. Accuracy no object for boat guns; 1984. The lead on our projectiles was put on by the tin process; 1990.

GORDON, HENRY WILLIAM, Captain, C.B. (*Analysis of evidence.*)

All guns issued for service, or those returned damaged, pass through my hands; 1745. Returns are no criterion by which to judge the proportion defective, as more than three-fourths of guns issued have not been fired; 1749. Approximately 2,900 Armstrong guns received; 1750. Guns returned for repairs are such as cannot be repaired at out-stations; 1751. Tools issued for repairs at stations, facing tools complicated, and almost impossible to keep pace with the changes of pattern of them; 1758. In old muzzle-loading smooth-bore guns venting tools only necessary, which are very expensive; 1759. The Whitworth guns have been experimental, a few only used, one of which, an 80-pr. breech-loading gun, became unserviceable; 1760. Wedge guns issued to Select Committee. Some going now for experiment at Portsmouth, Devonport, Sheerness, and Dover; 1761. They will require extra wedges and facing tools on issue for service in a proportion similar to that for vent-pieces; 1765. Out of three 70-prs. and two 40-prs. one of each had to be repaired after proof; 1772. Proving vent-pieces expensive, large number of guns destroyed by it; 1776. The inspection of projectiles rests with the Inspector of Artillery when made at Elswick. If at the Laboratory they are inspected there; 1781. Those unserviceable from the tin process cannot be reissued until modified; 1783. Order for fixing the lead by undercutting came out February 1861; but Elswick continued to supply those made by tin process until long afterwards. Zinc process first used at Laboratory; 1784. Tin process considered serviceable from December 1859 to February 1861; 1785. There have been no complaints against the process last introduced, and issued from about September 1861; 1786. Complaints received against the tin process from China; 1788. Elswick have just begun to use the zinc process; 1790. An immense number of shells, with which the tin process has been made use of, are still in the service on land and sea; 1792. Those from field artillery ordered to be exchanged; 1793. Will furnish return showing stores and tools required for one gun, considered as for ship or boat service, and for garrison or field artillery; 1795. Issues spare rings; 1796. The 110-pr. bouched in two different ways, viz., a thick or a thin ring. A demand made from two ships for rings could not be complied with, as the register number of guns was not sent to show whether the guns had thick or thin

rings; 1797. Guns now manufactured have the thin ring only, and if bouched before, have a thin ring now screwed into the thick one; 1798. This is a most delicate operation; 1799. The 110-pr. had originally no bouch, then copper, afterwards the thick, and now the thin ring; 1803. To describe vent-pieces, to form an opinion as to the cause of damage, it is necessary to state their number, whether made of iron or steel, and particular marks on it; 1808. Does not believe it possible to maintain supply to guns in event of operations on a large scale. In consequence of the frequent changes, 1809, would recommend the withdrawal of all ammunition that was not of the recognised pattern; 1810, 1811. Aware of one pillar fuze having exploded on removal to store; was one of the first made in Laboratory; 1812. Some shells from field batteries have been returned with their bases enlarged; could not load with them; caused to some extent by the limber box; 1821. When horse artillery changed their equipment, out of 1486 shells 394 unserviceable; 1822. No means of sufficient examination of Armstrong fuzes; 1828. Armstrong fuzes require great care in manufacture; 1830.

GRAPE. See CASESHOT AND GRAPE.

#### GUN FACTORIES:

For method of construction of the Armstrong guns at the Royal Gun Factories, Woolwich; *Anderson* 2327-2598, 2966-3224; *Noble* 3350-3353, 3472, 3586. Witness mentions that a cheap iron has been used in the gun factories for making coils, which will cheapen very much the manufacture of Armstrong guns; *ib.* 3457. Evidence that the cost of making the Armstrong guns can be ascertained at the Royal Arsenal, at the Gun Factories; *ib.* 3420, 3593. Witness states that a 120-pr. and a 70-pr. were made in the Gun Factories on the coil principle for Mr. Whitworth, and used by him at Shoeburyness; *Taylor* 1526-1528; *Anderson* 2485.

#### H.

##### HAMMER:

Evidence of the difficulty of welding thoroughly the coils in the Armstrong system, from the fact of their being unable to give them a good blow of the hammer, there not being rigidity enough in the structure; *Anderson* 2350, 2351. Method of hammering out the slabs to form the solid wrought-iron cylinder for the inner tube; *ib.* 2353, 2357. Inferiority of the welds in the first method of forming the breech piece from the want of proper hammering; *ib.* 2387. The ingots of steel for barrels of Armstrong guns is hammered and drawn out after receipt from the steel makers; *Noble* 3251, 3252. Evidence of the use of heavy hammers for the manufacture of homogeneous metal. (*Letter from Whitworth firm, App.* 201.)

HANDLES FOR VENT-PIECE. See HEATING.

HARRIER, H.M.S. See ACCIDENTS.

HARRISON, ARTHUR, Captain, R.A. (*Analysis of evidence.*)

Is secretary to Iron Plate Committee. Has seen all the experiments that have taken place with the Whitworth gun against iron plates; 1402. Mr. Whitworth's 70-pr. penetrated a 4-inch armour plate with 13 inches of wood backing, bursting inside the box target; 1405. Also penetrated 2½-inch unbacked armour with 12-pr. shot and shell; 1407. From his 120-pr., with an 130-lb. shell of homogeneous metal, penetrated the "Warrior" target, the plates on which were said to have been bad. Fresh plates were provided, and two shells weighing 151 lbs. each were burst in the wood backing, going through the plate, but gave little lateral damage. A shell of 130 lbs. also fired and apparently just burst as it penetrated the skin. 70-pr., at 600 yards, sent a shell of 81 lbs. through the plate, and it burst in the backing; 1410. Is of opinion that the penetration of armour plates is due to the quality of the metal in the projectile, always supposing the gun is able to stand a certain charge of powder, and is therefore of opinion that the Armstrong guns may be made to penetrate as well as the Whitworth; 1414. The Armstrong 110-pr. has penetrated with a shell the "Warrior" target, and bursting and blowing a hole through the skin, at a range of 200 yards; 1418.



the vent-piece will not stand a larger charge in the 110-pr. Armstrong, then the Whitworth gun ought to have the advantage in penetration. Saw one vent-piece break; it was not of new pattern; 1424. In the penetration of the Whitworth shell, a hole was merely punched through the plate; the fastenings were injured a good deal; 1428. Prefers muzzle-loading guns for penetration in consequence of the weakness of the vent-piece; 1435. In penetration no advantage in a flat-headed projectile; 1437. No fuze used in the bursting of either Armstrong or Whitworth shells against the iron plates; 1442.

HARRISON, RICHARD, Captain, R.E. (*Analysis of evidence.*)

Was with the force in China against the Peiho forts; 1863. Saw the Armstrong guns in action at Sinho route the Chinese cavalry at 1,200 yards' range; 1865. Saw 13 men and some horses killed by one shell with concussion fuze; 1866. Against the fortified village of Tangku the Armstrong shells most destructive to the Chinese behind their thin parapets; 1877. The guns opened first at 1,000 yards, then advanced to 600 yards; 1880. The impression on the army was that the Armstrong guns produced the most destructive effects; 1888. Before the action with Tartar cavalry, these guns had much knocking about in muddy roads in the most terrible way, notwithstanding which they opened fire when required; 1896.

HAY, CAPTAIN SIR JOHN C. D., BART., M.P., R.N. (*Analysis of evidence.*)

Having been chairman of the Iron Plate Committee, considers the comparative efficacy of the Armstrong and Whitworth guns against iron plates depends on their enduring powers in bearing the heaviest charges and giving the highest velocities, as the effect produced is due to the work of the shot on reaching the plate, together with the material of which the shot is made; 1832. Thinks that there are advantages in breech-loading in heavy guns, but want of confidence in them renders their use open to grave objection. Up to the 40-pr. breech loaders may be used with success; 1834. Considers it important that rifling projectiles should be coated with soft metal to prevent undue torsional friction on the metal of the gun; 1836. Would prefer rifle guns for the broadside, inasmuch as they perform the duty of the smooth bore, and give the accuracy and range of the rifle; 1840. As  $4\frac{1}{2}$ -inch plates on ships are invulnerable to small artillery, the limit of weight of a broadside gun cannot be put at much less than five tons, and thinks it would be safer to have them as muzzle loaders; 1841. For any service prefers the breech to muzzle loader if they could be made of endurance; 1844. Believes the shunt principle of rifling to be satisfactory; 1848. Thinks that the accuracy of fit given to the Whitworth projectile has done away the difficulty of loading with it; 1849. The Whitworth sabot prevents the shot moving from the charge; 1850. The displacement of a ship the means of limiting the size of her guns; 1852. Mr. Whitworth's shell, which has been driven through a ship's side, does not convey sufficient bursting charge; its merit consists in having had as a hollow projectile sufficient hardness and toughness to get through the iron plate without fracture; 1856. There are advantages in a flat-headed shot for penetration, when the flat part is considerably less in diameter than the shot, as it bites against iron plates when they are inclined at great angles; but if the plates be vertical there is no advantage; 1859. Experiments with iron plates tend to show that their resisting power is not materially increased by inclination 1862.

#### HEATING:

Witness observes that the heating caused from firing Armstrong guns would not render the coils slack from expansion; *Armstrong* 220, 221. Evidence of the inconvenience arising from the vent-pieces getting heated from rapid firing; *Cox, S.*, 335; *Cox, J.* 454; *Gardner* 2645. The addition of handles to the new pattern vent-pieces obviates the inconvenience felt from the heating; *Cox, J.* 458; *Liddell* 1175. The injurious effect of heating the breech piece so often in the welding, tending to make the metal granular and of inferior strength; *Anderson* 2399, 2433. Method of removing the outer coils by heating as pursued in the gun factories; *ib.* 2453.

HEWLETT, RICHARD S., Captain R.N., C.B. (*Analysis of evidence.*)

Commands H.M.S. "Excellent." Has had a great deal of practice with the Armstrong gun and some with the Whitworth; 2048. Has the highest opinion of the Armstrong gun as to safety, range, and accuracy. Believes that in the excitement of action the men may forget to screw up the breech piece. Has a 110-pr. in the "Excellent," in which four shells burst. Was easily repaired, and not by a specially instructed mechanic. Is still used with equal accuracy and range; 2049. The Armstrong has a number of advantages over the muzzle loader. Doubt the safety of the Whitworth gun, and considered its breech loading arrangements defective; 2051. Believes the principle of hard metal bearings in projectiles and guns with a severe twist will not stand long. With Whitworth's muzzle loader, found it difficult to get the shot home after a few rounds; 2052. Powder deposit getting into the angles of the rifling and hardening there the cause of difficulty in loading, although using sponge and lubricators; 2058. Notwithstanding the windage being small the shot started from its place in running the gun out, rendering a wad necessary; 2060. Practised with the Whitworth gun somewhat less than 30 rounds; 2063. Tried Mr. Whitworth's 80-pr. of homogeneous metal, which split after 20 or 30 rounds; 2068. On firing from Mr. Whitworth's cast-iron gun it became necessary to use the jolly boat's mast to get the shot home from the fouling in its bore; 2072. Considers the lead coating to Armstrong shot not objectionable, and believes all rifle projectiles should have soft outer skin. Considers it proved that the shot jamming in the Whitworth gun caused their bursting; 2076. Prefers the wedge Armstrongs to the screw breech loaders. Considers that system would be an improvement for the smaller naval guns, and for all others if the wedges can stand large charges; 2078. Two men can lift the vent piece of a 110-pr. with the greatest ease; 2082. Would not have a broadside gun of more than six tons; 2083. Considers that a pivot gun worked in the ordinary manner should not exceed five tons, but with mechanical arrangements, such as the cupola, there appears no limit in weight; 2084. Thinks it justifiable to bear with inconvenience in a gun when it secures perfect accuracy, although it is not so important at sea as on shore; 2091. Prefers breech to muzzle loaders, except for special purposes, such as smashing iron plates; 2092. Believes the manufacture of the Whitworth guns and projectiles could not be made so perfect as to prevent jamming in the bore; 2098. Considers the sponge cannot remove the fouling in the Whitworth guns; 2102. No difficulty in loading the Whitworth breech loader, but considers the same inconvenience will arise in them from the fouling; 2104. Considers the Armstrong a very good boat gun; 2110. Does not occupy more room in boats than the old gun—is in fact less in the way; 2112. No difficulty in landing with them, taking the sights out of the way; 2113. Prefers 20-pr. Armstrong to the old 24-pr. howitzer. Disagrees entirely with the evidence (of Captain H. C. Glyn 1947, Captain Seymour 2018) which states that four oars out of 14 had to be sacrificed to use the 12-pr. Armstrong for boat service. This gun has been shortened; 2118. Believes a combination of 12 and 20-pr. Armstrong in a field battery would be advantageous; 2121. The pillar fuzes have answered very well. The old pattern time fuzes deteriorate, and are irregular; 2122. The men in the "Excellent" appear to have perfect confidence in the Armstrong gun; 2131. Had three vent-pieces blown out, and about eight broken from firing; 2134. The projection on new pattern vent-piece ensures their not being blown out; 2141. Re-surface the copper rings of vent-pieces after 200 or 300 rounds, but some guns go on firing 600 or 700 without requiring it; 2145. fired 1,000 rounds from a 40-pr. Armstrong which was perfectly serviceable after it; 2147. Would not arm a ship altogether with rifle guns. The largest portion should be smooth bores. A more sensitive fuze required for parapet firing with Armstrong gun; 2151. Considers the breech loader infinitely more rapid in firing than the muzzle loader, under some circumstances, and under all has the advantage; 2154. Considers the coil system in guns an element of confidence, and if the vent-piece can be made indestructible can see no fault that could be found with the 110-pr. Armstrong; 2158. The breech screws stripped, but nothing to speak of; 2159. 110-

pr. Armstrong gun penetrated 20 to 22 inches of wood under water at a distance of 20 or 25 feet, and a three-inch iron plate at 20 feet; 2166. The penetration of the Whitworth flat-headed shot into water very good when fired from above the surface; 2168. Firing the Armstrong gun under water did not injure it; 2172. The effect of shell fired under water with pillar fuze at 20 feet range very great; 2174. Does not think Armstrong segment shell effective at very short ranges of about 150 yards and under; 2192. Would prefer a fuze lighted by the flame of the discharge if possible; 2195. At first great numbers of Armstrong shot stripped, but not latterly; 2204. Found no bad results from the smoke in firing Armstrong guns in the "Excellent;" 2210. Armstrong gun capable of bearing continued and rapid firing. Fired 100 rounds with one in 80 minutes; 2212. Likes the Armstrong time fuze better than the Boxer, because it can be set when in the shell; 2218.

HEXAGONAL. See RIFLING.

HOMOGENEOUS METAL. See STEEL.

#### HOOPING:

Witness believes that the defects in cast-iron guns might be got over if hooping were properly applied to them; *Anderson* 2333. Evidence that in putting on the Whitworth steel hoops cold by the hydraulic press that the full strength may be got out of them, if sufficient pressure be given to get them on conically, but it is not so simple or economical a plan as the shrinking on; *ib.* 3090. 3101, 3102. Evidence that no hoop will prevent the inner barrel from bursting; *Noble* 3505. Statement in disapproval of Mr. Whitworth's method of placing on the steel hoops by hydraulic pressure, and evidence of the Whitworth barrels turning round and spiking the gun: *ib.* 3562. Evidence considers that an extra hoop is required to the Whitworth gun when the vent is from above instead of in the prolongation of the gun's axis; *Whitworth* 3750-3753. Statement of the method of putting on the hoops of the Whitworth gun by hydraulic pressure; *ib.* 3894-3904. Denial that the barrels turn round, and thus spike the guns, and that the pressure on putting on the hoops is enough to prevent it; *ib.* 3907-3910. 4067-4069.

#### HORSFALL GUN:

Witness states that the most smashing effects he has seen against iron plates were produced by the Horsfall gun; *Gardner* 2722.

#### HOWITZERS AND SHELL GUNS:

Intention of witness to propose a shell gun or howitzer for field service, the details of which had not yet been worked out; *Whitworth* 26-34. Witness proposes as a howitzer the 20-pr. Armstrong of 13 cwt. for the field, and a 7-inch howitzer for siege purposes; *Armstrong* 194. Evidence of the want felt in existing field artillery equipments of an effective shell gun to act either in conjunction with the 12-pr. Armstrong or in distinct batteries, and recommendation that the short 20-pr. Armstrong should be adopted for field artillery; *Alderson* 605. 713, 714; *Milman* 842-844; *Milward* 1322-1329; *Desborough* 1447-1450. 1466; *Boxer* 1586, 1587; *Hewlett* 2121; *Gardner* 2616-2618. Statement made that a smooth-bore howitzer is more effective for boat service than the 12-pr. Armstrong; *Glyn* 1981; *Seymour* 2018.

HYDRAULIC PRESSURE. See HOOPING.

#### I.

IMPLEMENTS. See GEAR AND TOOLS.

IMPROVEMENTS. See ALTERATIONS.

INDIA-RUBBER RING. See FUZE.

INITIAL VELOCITY. See VELOCITY.

INNER TUBES, OR BARRELS. See FORGING.

#### INSPECTION AND PROOF:

The inspection and proof of Armstrong gun ammunition, formed almost entirely the witness's experience in the use of those guns, and was chiefly confined to the 12-pr.; *Boxer* 1569, 1570. Witness as Superintendent of the Royal Laboratory has nothing to do with the Armstrong projectiles made at Elswick, unless for repairs or alterations, they being inspected by the Inspector of Artillery; *ib.* 1679, 1680. In the

event of a return being required showing the number of rounds fired by an Armstrong gun the Inspector of Artillery could supply that information; *Gordon* 1749. The proof of vent-pieces stated to be an expensive business in consequence of their number being in excess of the guns, each requiring to be proved with full service charge; *ib.* 1775-1780. The inspections of Armstrong projectiles made at Elswick is done by the Inspector of Artillery, and those made at the Royal Laboratory are inspected by the Laboratory; *ib.* 1781. Statement of the proof charge of a 12-pr. Armstrong gun, and opinion expressed that a properly made gun of this system cannot be burst; *Armstrong* 136. Witness gives information of the numerous particulars and failures in the proof of the Armstrong guns at the Royal Gun Factories, and the care necessary in the inspection; *Anderson* 2359. 2364-2367. 2408. 2967. 3114. Evidence that heavy proof charges are injurious to an Armstrong gun as bringing the charge too far forward, and causing a strain to take place on a part of the gun not intended to bear it; *ib.* 2501. Detail of inspection of four brass Whitworth 12-prs. after experimental practice; *App.* 165. (See further at "Returns of examination.") Returns showing the number of guns proved and passed into the service at Elswick and the Royal Gun Factories; *App.* 164, 165. The inspection and proof of the steel for barrels of Armstrong guns very severe, a great number of barrels condemned, the uncertainty increases with the calibre; *Noble* 3231-3246. 3251-3258. Inspection made by the Whitworth firm of the steel barrels bought by them; *Whitworth* 3729. 3771-3776. 3787.

#### IRON, CAST:

Evidence of the want of safety felt in the use of cast-iron ordnance; *Liddell* 1149. There are many good points in cast iron for the construction of guns, the great defect is its uncertainty. Cast iron has not been properly applied yet, and might be turned to very good account if we could not get something better; *Anderson* 2329-2333. Method of making cast into wrought iron, by Morris and Sterling's patent; *ib.* 3096. Evidence that cast-iron guns with wrought-iron coils over them have burst largely; *Noble* 3520. 3525.

IRON PLATES. See PENETRATION.

#### IRON, WROUGHT:

The method of using wrought iron in bars on the coil principle is a good method of calling into action the full strength of that metal in the circumferential direction, but from the difficulty of welding, the longitudinal strength is not so great. It is, however, well adapted for the outer coils of guns, as from defects in welding, impurities in the metal or in the fuel used, it has been found that the barrels were often liable to imperfections in the bore; *Armstrong* 123. 136; *Anderson* 2350-2598. 2966-3224. Wrought iron much more easily welded than steel, and better suited to the exterior of guns; *Noble* 3340, 3341. In large masses of wrought iron uncertainty of quality exists; *Noble* 3339-3345. (See Forging and Hammer.) Witness would prefer inferior wrought iron to steel for outer coils; *ib.* 3502, 3503. The inferior wrought iron can be made up for in weight; *ib.* 3507. Statement that wrought-iron shot are no use for penetration of iron plates; *Whitworth* 4009-4013.

ISACKE, HENRY, Lieutenant R.A. (*Analysis of evidence.*)

I have seen practice with Armstrong and Whitworth guns; 2800. Four brass 12-pr. Whitworths fired 150 rounds each at ranges from 500 to 2,000 yards. They did not appear to have worn very much after firing, and were worked very easily; 2804. Twenty rounds were fired by one Whitworth in 13 minutes 40 seconds and beat the Armstrong by about one minute; 2807. Shot and shell were both fired. The Boxer fuze was used for the Whitworth shell; the concussion fuzes of the Armstrong shell were the most accurate; 2813. One or two fuses failed to ignite from the Whitworth gun; 2817. Did not think that the result of Boxer's shrapnel, as prepared for the Whitworth gun, was equal in effect to the Armstrong projectile; 2821. These shells travelled some distance after the explosion of their fuze in some instances; 2824. No difficulty in loading with hexagonal shot; 2825. No difficulty in sponging the Whitworth gun; 2834. Accuracy of the Whitworth gun very good; 2854. The Whitworth easier to work than the Armstrong gun to the men; 2859.



## K.

## KRUPP'S METAL AND GUNS:

Evidence given of the admirable quality of Krupp's steel, although too soft for the bores of guns. Opinion that the Bockum metal, from near Krupp's works, is as good as anything the witness has seen; *Anderson* 3012. 3098-3100. Mention made of the construction of the Krupp breech-loading gun, and favourable opinion given of its wedge and sunk steel cup; *ib.* 2971. 2990. Krupp supplies both the Armstrong and Whitworth firms with some of the steel used by them for their guns, and is the most expensive maker; *Noble* 3235. 3709; *Whitworth* 3728. Krupp's method of using large masses of steel for guns a failure; *Noble* 3517; *Whitworth* 3952-3954. 3961.

## L.

## LABORATORY:

Evidence that the projectiles manufactured at the Royal Laboratory are inspected and passed into the service by that department. Those made at Elswick are inspected by the Inspector of Artillery, the Royal Laboratory having nothing to do with them except for alterations or repair; *Boxer* 1679-1682; *Gordon* 1781. Statement of 100,000 Armstrong projectiles being sent to the Laboratory for reloading; *Boxer* 1677. Witness states that Colonel Boxer has had under consideration the form for shrapnel shell for the Whitworth gun; *Whitworth* 114, 115. Evidence of the Royal Laboratory having adopted the zincing process for fixing on the lead-coating of Armstrong projectiles, on Mr. Bashley Britten's system, opinion of its having been considered economical at the Laboratory although not found to be the case at Elswick; *Boxer* 1681-1687; *Gordon* 1784-1791; *Noble* 3632-3636. Letter requesting authority that the ammunition required for the trial of the Armstrong guns should be made at Elswick and not at the Royal Laboratory; *App.* 155. Letter from Whitworth firm respecting common shell sent to the Royal Laboratory; *App.* 202. Letter respecting the test for fuzes considered necessary by Colonel Boxer, superintendent of the Royal Laboratory; *App.* 203. Letter objecting to the superintendent of the Royal Laboratory withdrawing ammunition which had been supplied for the competitive trial of the Armstrong and Whitworth guns; *App.* 203. Letter from the superintendent Royal Laboratory submitting remarks for the consideration of the Committee on the ammunition for the Whitworth guns, supplied from the Laboratory; *App.* 203. Letter objecting to the shell supplied by Colonel Boxer for the Whitworth gun, from his being allowed to use alternative charges for bursting these shells; *App.* 204. Minutes and correspondence relative to shells requested to be made by Colonel Boxer for the use of the Armstrong gun: complaint of Mr. Whitworth for the same being allowed by the Secretary of State for War: and statement of Colonel Boxer that he is the inventor of the said shells, and not Mr. Whitworth: reconsideration of the permission given for Sir Wm. Armstrong to use the Whitworth shell; *App.* 205, 206. Letter objecting to Whitworth projectiles being placed for competition which had been perfected during the trials of the Committee; *App.* 206.

## LANCASTER GUNS:

Evidence of the bursting of two Lancaster guns at Kinburn; *Seymour* 2033. A comparison of the Lancaster gun taken with other rifle guns, to show that from the former having the greatest tendency to burst, the fact of its standing at all is a proof of the strength which may be expected from the others; *Hay* 1836; *Anderson* 2477-2480. Statement of the great amount of work done by the muzzles of the Lancaster guns, as tending to destroy them; *Anderson* 3168.

## LEAD-COATING TO PROJECTILES. See COATING.

## LENGTH:

Witness gives the length of the 1, 9, and 12-pr. Whitworth guns, and considers length in a gun an important element from its giving a low trajectory; *Whitworth* 5. 9. 71-73. Opinion given of the considerations which should limit the length of a gun; *Armstrong* 169-171. Statement that the 12-pr. Armstrong gun is inconveniently long to dismount, unless a hole is dug in front of the muzzle; *Cox*, S. 325. Witness thinks the 12-pr. Armstrong could be shortened with advantage, and although the naval short 12-pr. loses

a little in range yet it is a handier gun; *Alderson* 634, 635. Evidence that the Armstrong gun is too long for boat service; *Glyn* 1947; *Seymour* 2017. Tabular statements of the lengths of the Armstrong and Whitworth guns manufactured; *App.* 129-131. Evidence of the steel barrels for the Armstrong guns being supplied by the steel makers in certain lengths exceeding that required for the gun; *Anderson* 3010; *Noble* 3251. Lengths of the competitive 12-pr. guns (Armstrong and Whitworth); *App.* 209. 291. 333. Advantage of shortening the 12-pr. Armstrong for naval service; *Anderson* 2398.

## LEVER AND TAPPET RING:

Witness mentions that the keep pins for the tappet ring sometimes come out; *Cox*, S. 282. Evidence considers that the contingency of the lever being struck by an enemy's shot is the only serious objection to the Armstrong breech-loader; *Taylor* 1493. Witnesses conceive that if the breech-screw or lever handles were struck by a shot it would disable the gun: and a case was mentioned on board the "Defence," of the lever handle being knocked off by the recoil; *Milman* 918; *Powell* 2255, 2256. Evidence mentions the difficulty of sometimes working the tappet-ring; *Liddell* 1023-1026.

## LETTERS, MINUTES AND CORRESPONDENCE:

To the Secretary A. and W. Committee. From Sir W. Armstrong.

- 1st. January 17th, 1863. Forwarding tabulated statement (p. 160) of the various guns, &c. proposed by the Elswick Ordnance Company; *App.* 155.
- 2nd. January 21st, 1863. Request that the ammunition for the Armstrong guns under trial should be allowed to be made at Elswick; *App.* 155.
- 3rd. January 26th, 1863. Forwarding another tabular statement (p. 159) with a general description of the guns proposed; *App.* 155.
- 4th. February 26th, 1863. Requesting authority to furnish two new guns from Elswick in addition to one already supplied from Woolwich. Objection made to a contrast being made between the 70-pr. Armstrong of 60 cwt. and the 70-pr. Whitworth of 80 cwt. for the penetration of iron plates; *App.* 202.
- 5th. October 27th, 1863. Proposing  $6\frac{1}{2}$ -ton and 12-ton guns to be used against iron plates, the first with 68-pr., the latter with the 10-inch bore; *App.* 202.
- 6th. January 25th, 1864. Statement that each competitor should deliver their guns and ammunition before the trials commenced; *App.* 203.
- 7th. January 25th, 1864. Remarks on the testing of fuzes, and request to be allowed to submit less sensitive fuzes, capable of bearing the test; *App.* 203.
- 8th. April 6th, 1864. Objecting to Colonel Boxer withdrawing for experiment some of the ammunition supplied for the Whitworth gun; *App.* 203.
- 9th. June 16th, 1864. Objecting to the Boxer shell for the Whitworth being allowed two bursting charges; *App.* 204.
- 10th. September 10th, 1864. Request to be allowed to use the Boxer elongated shrapnel for 12-pr. shunt gun; *App.* 204.
- 11th. October 17th, 1864. Application to the Committee for 12-pr. gun, for Colonel Boxer to try experiments with shrapnel shell; *App.* 205.
- 12th. October 19th, 1864. Observing that two different kinds of shells were permitted for the 70-pr. Whitworth, contrary to previous agreement; *App.* 206.
- 13th. October 19th, 1864. Objection to 12-pr. case shot having been supplied by Mr. Whitworth after the specified time, and placed in competition with Armstrong case shot; *App.* 206.
- 14th. October 26th, 1864. Objection to the trial for rough usage for the Armstrong projectiles, they being packed with the Whitworth shot, and liable to damage thereby, more than when placed together by themselves; *App.* 206.
- 15th. November 1st, 1864. Further objections on the subject of letter No. 13; *App.* 206.
- 16th. November 7th, 1864. Statement that verbal application had been made to allow of more windage to the 70-pr.; *App.* 206.

- 17th. November 17th, 1864. Complaint that Mr. Whitworth had been allowed to use two natures of shell; *App.* 206.
- 18th. November 21st, 1864. Request that the incomplete practice of the 70-pr. in the marshes, should be struck out of the records of the Committee; *App.* 206.
- 19th. December 16th, 1864. Further objections on the subject of letters Nos. 13 and 15; *App.* 207.

*To the Secretary A. and W. Committee. From Joseph Whitworth, Esq.*

- 1st. January 24th, 1863. Relative to the tabular statement of the Whitworth guns rendered to the Committee, and proposal of the 12-pr. and 70-pr. for competition; *App.* 157.
- 2nd. January 29th, 1863. Regarding the inspection by the Committee of the manufacture of the Whitworth guns; *App.* 201.
- 3rd. February 17th, 1863. Acknowledgment of the order for the manufacture of three 12-prs., and three 70-prs.; *App.* 201.
- 4th. June 17th, 1863. Relative to the delay in the delivery of the Whitworth guns for trial; *App.* 201.
- 5th. September 4th, 1863. Statement that the Whitworth guns would be ready for delivery in three or four weeks; *App.* 201.
- 6th. October 2nd, 1863. Relative to ammunition to be supplied by the Royal Laboratory, and carriages by the Royal Carriage Department; *App.* 201.
- 7th. December 17th, 1863. Relative to the delay in supplying 70-pr.; *App.* 201.
- 8th. January 26th, 1864. Regarding the delivery of the Whitworth guns; *App.* 201.
- 9th. February 5th, 1864. Relative to the delivery on the 14th March of the Whitworth competitive guns; *App.* 202.
- 10th. March 14th, 1864. Advice of the despatch of the Whitworth guns and ammunition; *App.* 202.

*To the Secretary of State for War. From Joseph Whitworth, Esq.*

- 1st. December 25th, 1862. A comparison of the Armstrong and Whitworth systems of ordnance; *App.* 157.
- 2nd. January 12th, 1864. Relative to bill for the stores supplied to the A. and W. Committee, and notice of delivery of heavy guns; *App.* 201.
- 3rd. January 28th, 1864. Request that 10 rounds of case shot be supplied for 12-pr. Whitworth. Statement that it was not possible to deliver the 70-prs. at the required date; *App.* 201.
- 4th. October 27th, 1864. Objection to the shrapnel shell invented for the Whitworth gun, being used for the Armstrong gun; *App.* 204.

*Ordnance Select Committee. To the A. and W. Committee.*

- January 19, 1863. Forwarding memorandum of the experiments for penetration of Armstrong and Whitworth projectiles; *App.* 157.

*A. and W. Committee. From Chemist of the War Department.*

- January 23rd, 1865. Statement of the chemical examination of the runnion piece of a Whitworth gun; *App.* 202.

*A. and W. Committee. From Lieut.-Colonel Boxer, R.A.*

- 1st. April 29th, 1864. Suggestions as to the trial of the ammunition supplied for the Whitworth guns; *App.* 203.
- 2nd. August 29th, 1864. Statement that the principal of construction of the Whitworth shrapnel is equally applicable to the Armstrong gun; *App.* 204.

*A. and W. Committee. From Major-General St. George, Director of Ordnance.*

- February 27th, 1864. Statement of 1st April being the date fixed for the competitive guns being delivered; *App.* 203.

*Major-General St. George. To Joseph Whitworth, Esq.*

- 1st. November 28th, 1864. Statement that Mr. Whitworth had nothing to complain of in his shell being used for the Armstrong gun; *App.* 205.

- 2nd. December 6th, 1864. Further correspondence respecting the Whitworth shell being used with Armstrong gun, and withdrawal of the permission; *App.* 205.

*Major-General St. George. To Sir W. Armstrong.*

- December 6th, 1864. Decision that the Whitworth shell cannot be supplied for the use of the Armstrong gun; *App.* 205.

*Secretary of State for War. From Sir W. Armstrong.*

- September 18th, 1864. Application for a supply of the Boxer shrapnel for the Whitworth gun, to be supplied for the Armstrong shunt gun; *App.* 204.

*Superintendent Royal Gun Factory and Secretary A. and W. Committee.*

- Letters, 26th April, 29th April, 2nd May, 1864, relative to the correction of the sighting of the competitive Armstrong and Whitworth guns; *App.* 208, 209.

#### LIABILITY TO INJURY:

General evidence of breech-loading guns being more liable to injury than muzzle-loading; *Cox, J.* 449. 467. 476; *Milman* 917; *Powell* 2255; Witness states there is no danger to the crew in loading a breech-loading Armstrong, but in firing, thinks the liability to accident rests with that kind of gun; *Rice* 1915.

LIDDELL, WILLIAM HENRY, Lieut., R.N. (*Analysis of evidence.*)

Is first and gunnery lieutenant of the "Excellent." Has seen all kinds of Armstrong guns fired except 6-pr.; believes their range equal to the wants of the service, and thinks that if the range were longer the trajectory would be lower; 946. Accuracy of these guns of all natures very good; 953. Prefers the Armstrongs to others as boat guns; 970. Also as pivots, for accuracy; 972. And is the best gun for cupolas, if it would do for penetration, 974. Seamen under instruction generally are convinced of its accuracy; 975. The disadvantage of the Armstrong breech-loader is the liability of the vent-piece being blown out; 989. The vent-pieces crack; 995. The 40-pr. Armstrong admirable as a broadside gun; 1004. A few instances occurred where the shot did not take the rifling from not being home on the charge; 1005. The tin cups cause vent-pieces to jam sometimes; 1008. Old pattern time fuze acts badly; 1016. Also dangerous if the shell receives a fall; accident in the "Stork"; 1018. A fuze is required to explode shell dropped over a parapet with a small charge; 1020. Tappet-ring difficult to work after a few rounds; 1023. With the exception of the 110-pr. the rapidity of fire from Armstrong guns greater than smooth-bores; 1028. With the 40-pr. saw six rounds fired in 2 minutes 40 seconds; 1032. Breech-loaders advantageous on board ship; 1041. The men had no difficulty in taking out the vent-piece of the 110-pr.; 1052. Apprehends no difficulty with vent-piece when clearing for action at night; 1055. Armstrong breech-loader capable of standing rough usage at sea; knows no reason why they should not be used on the roughest service; 1064. A difficulty in dismounting heavy Armstrong guns; 1066. Prefers breech-loader to muzzle-loader; 1072. Found common shot give more penetration under water than any other; 1080. Could not hit a ship below the water-line by a gun fired from above it, with the amount of depression possible on naval carriages, of 7° to 8°; 1084. Armstrong projectiles have greater destructive effect than the 68-pr.; 1089. All Armstrong projectiles satisfactory, except the 110-pr.; 1096. Projectiles liable to injury in transmission, but not generally serious; 1098. Objects to material and shape of 110-pr. projectile; 1109. Two or three shells we fired with reduced charges in 110-pr. burst in the gun; 1128. For the field and in boat guns, great advantage of one kind of projectile; 1133. The old rectangular thread on the breech-screw was defective, the new pattern is not so; 1147. Great feeling of security given by wrought-iron coiled guns; 1149. Breaking thread of breech-screw caused by firing in one instance; 1157. Recoil of 40-pr. little more than 8-inch gun; 1159. Breeching rope of eight inches for 40-pr. the same as used for 32-pr. smooth-bore; 1165. The 68-pr. and 10-inch have greater recoil than 110-pr.; 1166. Saw a 40-pr. fire 100 rounds in 86 minutes; the vent-piece did not get



too hot, but the copper ring came off after about 80 rounds; the gun was pointed each time, and the shooting was good; 1172. The 40-pr. Armstrong, as compared with the 32-pr. smooth-bore gun, requires less room for stowing ammunition; 1188.

#### LINED GUNS:

Statement that steel-lined guns should not be supposed to have merely a thin lining, but consist of the entire inner tube of steel, introduced instead of one made of wrought iron; *Armstrong* 205. Some guns into which thin linings had been introduced, were found after proof to have had these linings moved; *ib.* 208-210.

Witness gives information as to the method pursued in the gun factories in lining the Armstrong guns, and explains the difficulty in performing the operation; *Anderson* 2368.

LOADING. *See* DRILL.

LUBRICATION. *See* FOULING.

#### M.

#### MACHINERY:

Witness states that the proper machinery for the manufacture of the Whitworth projectiles was not in the Royal Laboratory. Would not require so much as for the Armstrong projectiles, and in making an estimate he assumes the proper machinery is used, and allows for its cost, the interest of capital and repairs; *Bower* 1673-1675. Statements contradictory of the above; *Whitworth* 4017-4020. A great deal of difficulty is got over in the manufacture of the Armstrong gun by machinery; *Anderson* 2533. The complication of machinery required for the repair of the wedge gun; *ib.* 2977-2985. The first cost of experimental guns and stores is necessarily higher than the expenditure required to supply them in large quantities, from the fact that new guns require the adoption of special machinery, the expense of which can be spread over the estimate for a large contract; *Noble* 3687-3689; *Whitworth* 4000-4006. Time the best criterion of cost when working with machinery; *Whitworth* 4006, 4007. Opinion of witness that in the event of a sudden demand for guns, that the marine establishments could be made available for their manufacture, as their present machinery could be used, and would only require some small additions; *ib.* 4109, 4110. Statement that turning is the cheapest method of surfacing, and is the only nature of machinery at which there is no waste of tools; *Noble* 3627.

#### MERCER, CAPTAIN, late R.A.

Witness mentions report of Captain Mercer on the subject of the performance of the Armstrong guns in New Zealand, and differs in opinion with Captain Mercer on the results attained; *Seymour* 1993. 2003. 2010. 2012.

#### METAL, MUNTZ'S AND AUSTRIAN.

The mechanical properties of the Austrian or sterra metal, are very high, and it is much like the Muntz's in its composition, being composed of 60 parts copper, 40 of zinc, 4 of iron, and 2 of tin, that of the Muntz being 60 of copper and 40 of zinc. A gun made of the Muntz metal was found to become unserviceable from the melting out of the zinc from the heat caused by continued firing. Mention of the property of the sterra metal to increase in tenacity when cast and suddenly cooled, its strength going up to 25 tons thereby; *Anderson* 2339-2346.

#### MILMAN, GEORGE ALDERSON, MAJOR R.A. (*Analysis of evidence.*)

Is Captain Instructor at the School of Gunnery; 723. Rifle guns now in use give range enough for service; 726. A fire could be made very effective from this gun on a front of 50 yards from a distance of 3,000 yards; 728. Mr. Whitworth's gun has the advantage in range; its accuracy great; 735. The initial velocity of 12-pr. Armstrong, 1,242 feet; 70-pr. Whitworth, 1,184 feet per second; 745. In retardation much depends on the shaped head of the projectile; 753. A competent gunner would hit a six-foot target at 1,000 yards 14 or 15 times out of 20 shots with the Armstrong gun; 757. Does not think that greater accuracy or certainty could be desired with the Armstrong gun, as also the Whitworth; 763. 12-pr. easy to work; a detachment could be taught

the drill in five days, except the No. 1; 782. Likes the 20 and 40-pr. Armstrong very much, but not the 110-pr. Takes the latter too long to load when elevated, and the vent-piece is too heavy; 792. Wedge system admits of easier working; 796. The vent-pieces cause the 110-pr. to work heavier than 68-pr.; 808. No difficulty in working the shunt guns; 811. With 12-pr. five rounds take an average of three minutes 40 or 50 seconds to fire; 819. Tin cups cause the vent-pieces of 110-pr. to jam sometimes; 828. One kind of projectile for field guns advantageous, from its simplicity, and is equal to all requirements, as compared with 9-pr. smooth-bore for round shot and shrapnel only; 832. Some arrangement necessary for firing case; 836. Proposes short 20-pr. for batteries as a shell gun; 843. Recommends time and concussion fuze in each shell; 846. All natures of Armstrong projectiles satisfactory for the purpose for which they are intended; 856. Molten iron can be fired from 110-pr., but is of no value; 859. Knew one 12-pr. Armstrong to have fired 3,000 rounds, and is still serviceable. After 250 rounds the vent-piece requires refacing; 865. Copper ring should be removed after 800 or 1,000 rounds; 873. Refacing no practical disadvantage; 874. Should prefer muzzle-loader to breech-loader as a system, if the former were equal in the advantages of the latter; 879. Field carriages too weak on upper part of trail; 887. Has known the 110-pr. vent-piece jam; 909. Thinks vent-piece of heavy 110-pr. too weak; 912. The complication of breech-loading no drawback on service, but is more liable to damage from enemies' fire; 917. Has a favourable opinion of present pattern time and concussion fuzes; 919. The action of pillar fuze good; 929. It would be advantageous to have all fuzes with the same thread of screw; 934. Is of opinion that the effects from stripping are not so bad as those caused by wood bottoms of smooth-bore projectiles; 936.

#### MILWARD, THOMAS, MAJOR R.A. (*Analysis of evidence.*)

Commanded a battery of Armstrong 12-pr. 6 cwt. field guns in China in 1860. These guns were special; 1309. The range was very good, and shell acted well with concussion fuses, the time fuzes were bad, having been injured on voyage out from damp; 1316. Effect of shell at 450 yards was greater than from common smooth-bore case shot; 1317. You can pick up your range with concussion fuze; it will be seen when the shell bursts; 1319. Our shells produced great effect at 2,000 yards; 1320. We felt much the want of a common shell with large bursting charge; 1322. Recommends shortened 20-pr. Armstrong as a shell gun; 1325. Would have them in distinct batteries to simplify ammunition; 1328. Considers Armstrong gun sufficiently accurate; 1331. Our fire at 600 yards had the effect of obliging the enemy to desert their guns; 1335. At one place a whole gun detachment were killed with our segment shell. Our fire was direct; 1338. Found no difficulty in working our guns, sponged out after every 10 rounds; we had no lubricators; 1345. Our shells were not injured in transport, although they had much knocking about on board ship; 1351. Considers the effect of bursting a segment shell just in front of an embrasure would disable the gun detachment; 1354. Found the traversing arrangement useful when the wheels stuck in soft ground; 1358. Had but one accident with a vent-piece from not being screwed up; 1359. Found great advantage in having only one kind of projectile; 1364. My guns had some very rough work. Everything was covered with mud; they were soon cleaned, and as effective as before; 1365. Has found no inconvenience from breech-loading system; it requires more training and steadiness in the men; thinks the muzzle-loading simpler, and would prefer it, if the advantages of the Armstrong gun could be retained; 1379. Does not believe there was a man killed in front of his battery, while firing over the heads of the troops, by stripping the shells; 1383. Found only one shell burst in the bore, caused by a defective fuze; it did no injury to the gun; 1387. Nothing happened to us that we could not have repaired ourselves without a civil artificer; 1391. We faced our vent-pieces after 200 rounds; 1392. Would prefer a larger calibre and a shorter gun than 12-pr. if it did not increase its weight; 1395.

#### MOLTEN IRON.

Evidence given that molten iron may be used in Armstrong shells, but that the general effect is not



very great, and they do not seem to be of any practical value; *Alderson* 678; *Milman* 859; *Taylor* 1563; *Gardner* 2608.

MOORSOM FUZE. See FUZE.

#### MUZZLE-LOADERS.

Evidence in favour of muzzle-loading for ordnance generally; *Whitworth* 53; *Bechervaise* 1217; *Rice* 1927; *Seymour* 2015, 2031. Witnesses state that muzzle-loaders would be best adapted for field service; *Alderson* 584; *Milman* 879; *Milward* 1379; *Desborough* 1463; *Glyn* 1955; *Gardner* 2611, 2612. Statements made of preference felt in the use of muzzle-loading for heavy guns; *Cox, J.* 471. 473; *Alderson* 690; *Gardner* 2611, 2612. Witnesses believe that muzzle-loaders will be required for the penetration of iron plates, as giving more promise of strength than breech-loaders to stand the action of large charges; *Harrison, A.* 1435; *Hay* 1841; *Hewlett* 2092. 2187. Evidence given that the muzzle-loader would afford means of more rapid firing than the breech-loader; *Cox, S.* 292. 383; *Cox, J.* 480. 526; *Powell* 2285; *Gardner* 2606. Witness states that, owing to the confined space in cupolas, that there would not be room to load a muzzle-loader; *Powell* 2246. Evidence states that it is a matter of choice for the service to determine whether there should be muzzle or breech-loaders, as either can be produced as far as mechanical questions are considered; *Armstrong* 147; *Anderson* 3066. Evidence of the efficiency of the Armstrong muzzle-loading shunt gun, as to accuracy, range, and ease of working; *Cox, J.* 568; *Alderson* 647; *Milman* 810-814; *Hay* 1848. Witness mentions the mechanical difficulties in rifling the shunt gun; complains of its want of simplicity, and considers the shunt arrangement could be done without; *Anderson* 3162-3167. 3204. Statement of the number of grooves in the shunt guns to be six for the 150-pr., eight for 300-pr., and ten for 600-pr.; *Noble* 3663.

#### N.

#### NEW ZEALAND.

Evidence of the results obtained in the use of the Armstrong guns in New Zealand; *Glyn* 1944-1990; *Seymour* 1991-2046.

#### NINE-POUNDER ARMSTRONG GUN.

Witness proposes the 9-pr. Armstrong gun for the Horse Artillery; *Armstrong* 119. Weight, calibre, length, &c. of 9-pr. Armstrong guns; *App.* 160. Particulars of the manufacture of the 9-pr. Armstrong gun; *Anderson* 2406. 2447-2452. Evidence of the manner in which the 9-pr. gun stood hard usage; *Alderson* 698; *Taylor* 1491.

#### NOBLE, ANDREW, CAPTAIN. (*Analysis of evidence.*)

The witness states that the construction of the different 12-pr. guns is similar. They have steel barrels, which are supplied solid by the trade, and no patent right has ever been paid on them, either by the steel makers or the Armstrong firm; 3225-3230. The barrels are bored and tested in various places, pieces are cut off for the proof of the metal before the barrel is bored. The liability of steel to contain flaws is excessive, and requires the greatest care, none of the barrels made by the best makers are perfect; 3231-3235. The quality of the steel is improving, but still the flaws continue; Mr. Whitworth has the same defects to complain of. There are a large per-centage of the barrels bad. With the 12-prs. there is comparatively little difficulty; but with the 150-prs. we return now as much as 30 per cent. to the makers. There are greater chances of failures in large masses of steel than in small ones. The number of rejections in the 12-pr. is not more than 10 per cent.; 3236-3246. Having written to the steel makers, they stated they did not pay any patent right. The ingots are cast with a dead head, and when received from them they are drawn out, discs cut off from each end, from which rectangular bars are formed, and subjected to proof for toughness, by bending to a certain angle. The bottom of the ingot while casting is the best part, and is placed in the breech of the gun. The barrel is bored and examined for flaws. The steel is of a very mild quality, converted from Swedish iron and run into ingots; it is of a different quality from tool steel, and its cost varies according to size from 70*l.* to 120*l.* per ton; 3247-3268. From the earliest manu-

facture of the Armstrong gun steel has been tried for barrels, and the great trouble given by them at first caused their being abandoned. The use of steel for large guns was commenced in 1862, with the 70-prs. towards the end of 1862, and the 12-prs. at the commencement of 1862. The guns in the service as yet from Elswick are all "coiled" with a few exceptions; 3272-3281. No inferior steel has been used at Elswick for guns. Thinks the Bessemer steel could be used up to the 70-prs., for which size and the 12-pr. the ingots would cost from 50*l.* to 60*l.* per ton, it is thus high, as it would probably be the Bessemer steel remelted. Steel may be expected to cheapen, but has considerable doubts of its being the best material for gun making. Places dependence for strength upon the hoops outside the steel barrel. For a 12-pr. a gun might be made of steel alone; 3286-3302. The fair average cost of the steel for 12-prs. is 70*l.* per ton, and the cost of the finished barrel would be about 140*l.* per ton, exclusive of labour. Considers that the use of the steel barrel for the 70-pr. should be fully recognised, not as regards strength, but for freedom from flaws. Sir W. Armstrong prefers the steel barrel to the coiled one; 3303-3324. The inability of steel to stand percussive action as well as wrought iron, has led to the belief that it will not succeed ultimately as a gun metal. Considers there is no advantage in substituting steel for wrought iron. It is when large masses of wrought iron are welded that uncertainty prevails. And in making a cylinder, the only uncertainty which exists is in the welds; 3329-3348. The solid forged barrels made at Woolwich were an utter failure, from their liability to have longitudinal flaws; their manufacture is now abandoned. The welds have only 50 to 60 per cent. of the strength of the original bar from which the cylinder is made. The comparative tensile strength is obtained by small bars cut out and broken by tension. Steel is acted upon slightly more than wrought iron by the action of the powder. But where there are defective welds in wrought iron the powder will eat in more; 3349-3370. The mild steel will weld, but not well. The 12-pr. barrels have been tempered in oil after they are bored and turned. The large barrels are inconvenient to temper, and the effect on them would be questionable. The method of tempering the barrels in oil is determined by the practical knowledge of the workman of the material. The evils of tempering in large masses are greater than the advantages to be gained. In tempering barrels they may get crooked, and it denotes a want of homogeneity; 3372-3400. There is great additional expense in preparing steel as compared with wrought iron. The cost of the Armstrong guns with steel barrels depends upon what is put upon them for depreciation, whether you include simply workmanship, or the value of machinery and depreciation of plant. The cost of the barrel would be about 50 per cent. above the cost of the ingot as delivered, or taking it first as costing 35*l.*, when finished, would amount to 52*l.* Large guns are being made at Woolwich in exactly the same way with steel barrels. It is hardly necessary to go into details to ascertain the relative cost of the Armstrong and Whitworth guns, as the former are made of much cheaper material, they must cost less, both kinds being built up; 3401-3427. The price of the shunt and breech-loader comes to the same, the latter being lighter. The price of 12-pr. given in former list was 90*l.*; for the breech-loader, as delivered to the Committee, 254*l.*, and 226*l.* for the shunt, not one-third of these sums should be taken as a fair average price. Mr. Whitworth asks, 3,000*l.* for a 300-pr.; the Armstrong price is 1,620*l.*, and it stands to reason that if a material costing 80*l.* in the rough is used for guns, that they must be more expensive than if made of metal costing 20*l.*; 3428-3447. The coiling and welding the wrought iron increases the prices of material to 30*l.* per ton. In the gun factories an iron is being used for coils costing from 12*l.* to 14*l.* a ton, and if it is found to answer it will reduce the cost of coil guns to a great extent. The iron used in the Armstrong guns is of the very best description. All experience goes against steel being better than iron for guns. Four of the Whitworth guns supplied to the Egyptian Government failed, and also some made for the Danish Government. There has been no lives lost by the Armstrong guns bursting, while several have been sacrificed by the instances mentioned of the Whitworth. The gun factories are making efforts to retain the coiled barrels from the uncertainty of steel; it is uncertain whether

steel or wrought iron barrels will ultimately prove the best; 3448-3479. Sir W. Armstrong objects to steel for ordnance, from its not standing a sudden blow; it is notorious among those who have used iron, that tensile strength is no test of fitness to stand percussive strain. The action of gunpowder within a gun may be compared with the action of the projectile striking a plate, both being a sudden and percussive force. Considers that inferior wrought iron would be better than steel for the outsides of guns and if inferior iron was used it might be made up in strength by more weight; 3483-3509. Steel in the barrels is not depended on, but is strengthened with wrought iron coils, the outside taking the strain as well as the inside. One and all are giving up the use of steel in the solid form for guns. Cast-iron guns burst equally, whether there are hoops on them or not; they have none of the properties of built-up guns. A matter of importance to have the element of strength preserved on the outside of the gun, and if steel could be made so it would be adopted. The value of a gun might be determined by its endurance; 3510-3535. When the barrel is prepared, the coils are shrunk on. There is a certain amount of contraction allowed for, the object being to get a tensile strain upon the coils. The temperature to which they are brought is a dull red heat, about 1,000° to 1,200° Fahrenheit. There is a constant stream of water flowing inside to keep the gun cool; 3544-3558. Considers that the method of putting on coils by hydraulic pressure is not superior to shrinking them on; refers to General Gilmore's report of the Whitworth guns spiking themselves. There is no difficulty in turning and shrinking on the cylinders, either parallel or with a taper. On the 12-pr. there are four coils over the barrel, placed on one after the other. The breech screw in the 12-pr. muzzle-loading Armstrong is of steel, and in the 70-pr. of iron. The breech-piece is forged so as to have its strength running longitudinally. The guns in the arsenal are welded exactly the same way. The breech-screw can be taken out after the gun has been fired. The cost of a 70-pr. steel barrel finished will be 210*l.* per ton; 3562-3594. Sir Wm. Armstrong's opinion is, that the cost of the guns vary as the material, and if Mr. Whitworth will make a bonâ fide statement of what he is making his guns for, Sir Wm. Armstrong is prepared to do the same, referring the Committee to foreign ambassadors for the prices at which guns have been supplied to their governments; 3595-3604. Any system of rifling makes very little difference in the cost of guns. Considers that the workmanship of the Whitworth cannot be done cheaper than the Armstrong gun. The breech-loading 12-pr. Armstrong was intended to fire shell, and it was never meant to fire shot. Breech-loading apparatus is of itself more expensive than muzzle-loading, if guns of equal dimensions are compared. The limit of the weight of a gun to that of the shot depends on the size of the former, and the compression which can be given to the gun carriage in recoiling; in the 9-pr. and 6-prs. the proportion is as low as 90 to 1; 3607-3625. With regard to cost of projectiles, if they were ordered in large quantities, they could be supplied at 25 to 30 per cent. below what they cost the Committee. Considers turning the cheapest mode of surfacing projectiles. Prefers undercutting to placing the lead on by the zinc process, and believes it cheaper, although the Royal Laboratory experience is the reverse. Undercut projectiles when carried in limbers have the lead on the shot sometimes shaken loose, but on the whole they bear travelling as well as the old smooth-bore projectiles; the shunt are, however, better in this respect; 3626-3647. The cost of tools to accompany the breech-loader add about 2 per cent. to the cost of the gun, but would be inappreciable for a battery, as one set is sufficient for six guns. There is very little difference in the cost of the breech-loading and shunt projectiles, and it is slightly in favour of the latter. Recommends the holes for the studs of the shunt being bored instead of cast. The number of grooves for the shunt guns is six for the 150-pr., eight for 300-pr., and ten for 600-pr. The number of studs is determined by the pressure which drives the projectile; 3648-3665. Mentions that a number of 12-pr. segment shell have been supplied at 2*s.* 10*d.* each; 3648-3675. The cost of fuzes would be, for time fuze, 2*s.* 6*d.*, concussion, 1*s.*, and the pillar fuze, 1*s.* 10*d.* We offered the time fuze at 2*s.* The fuze adapter, 6*d.* It was shown to the Committee on Ordnance that the Armstrong projectiles were supplied at a lower price per ton than the rate at which

the diaphragm shrapnel shell were manufactured for Government. The price of the 110-pr. common shell at first was 23*s.* 6*d.* each, which was reduced to 13*s.*; 3676-3689. The barrel of the 600-pr. Armstrong was cast as a tube, and drawn out on a mandril. The ingot for a 300-pr. wound cost 300*l.*, or about 100*l.* per ton; the relative cost of the wrought iron would be 55*l.* 24 tons of material required to make a 12-ton gun. A 600-pr. barrel is worth 600*l.* before anything is done to it, and 150-pr. is worth 180*l.* Krupp is the most expensive steel maker. The expense of tool steel is about 70*l.* per ton. Special instruments have been constructed for rebushing the side-loading breech-loaders; 3676-3719.

#### NUMBER :

Witness explains the method of giving credit by numbers for practice carried on in the "Excellent;" Liddell 1183. Evidence gives 2900 as the number of Armstrong guns that have been received into store at Woolwich; Gordon 1750. Statement of the number of Armstrong shells requiring releading in the Arsenal to be 100,000, and the number of new fuzes making in the laboratory is 50,000; Boxer 1677, 1723. The number of Armstrong guns mounted at Gibraltar 50, at Malta 40, and at Portsmouth 40; Gordon 1749. Evidence showing the number of rounds fired in June quarter 1862 at Shoeburyness; Taylor 1552. Evidence of the immense number of Armstrong projectiles prepared with the tin process, all over the world on land and sea; Gordon 1792. Witness states the number of Armstrong guns made at the gun factories Woolwich; Anderson 2350, 2351, 2356, 2359. Return showing the number of guns made in the gun factories and Elswick up to March 1863; App. 164. Return of the number of the Armstrong guns issued; App. 167.

#### O.

##### ONE HUNDRED AND TEN-POUNDER ARMSTRONG GUN.

Witness states that the 110-pr. cannot be fired quite so fast as the 68-pr. smooth bore; Cox, S. 333. The 110-pr. is on the whole a heavier gun to work than the 68-pr.; Alderson 648, 649; Milman 804; Rice 1911. The 110-pr. is complicated, and when firing at high angles, the gun requires to be depressed before loading; Milman 788, 790. Evidence of the vent-piece jamming in the 110-pr.; Milman 902-913; Liddell 1035; Bechervaise 1209. Statement in favour of the employment of the 110-pr. as a pivot gun; Liddell 972. 1037; Bechervaise 1209; Rice 1939, 1942. Witness states the 110-pr. is better adapted for cupolas than any gun he knows of; Liddell 1092. Evidence in favour of the 110-pr. as a broadside gun, more particularly from the result which may be obtained by firing from it a projectile of 68 lbs. in weight with the service charge of powder; Hay 1840.

##### ORDNANCE SELECT COMMITTEE :

Witness gives evidence of 1450 as the number of rounds fired at Shoeburyness for the Ordnance Select Committee for the quarter ending 30th June 1862; Taylor 1552. Evidence states that the Ordnance Select Committee made a number of experiments to determine the initial velocity of the Whitworth gun; Boxer 1665. Statement of some wedge guns being issued to the Ordnance Select Committee; Gordon 1761. Witness states that it rests between the Ordnance Select Committee and the Inspector of Artillery whether it matters if the lead-coating of Armstrong projectiles be loose or not; ib. 1789. Evidence of the breech-loading system for ordnance proposed by Mr. Westley Richards being under the consideration of the Ordnance Select Committee; Hay 1835. Witness states that he suggested to the Ordnance Select Committee, the necessity of coating the gas pipe bursters for Armstrong shell with a preparation to protect them from rust; Bent 2757. Letter from Ordnance Select Committee, forwarding a return of the experiments, made to ascertain the penetration of the Armstrong and Whitworth guns; App. 157, 158.

##### OIL. See FOULING AND TEMPERING.

#### P.

##### PARAFET-FIRING. See FUZE.

##### PATTERNS, CHANGES OF. See ALTERATIONS.



## PENETRATION:

Evidence of the necessity of employing larger guns than hitherto used in the service, for the penetration of iron-plated ships; *Armstrong* 164; *Alderson* 662; *Harrison*, A. 1414; *Letters of Sir W. Armstrong*, App. 156-203. Statement that in the experiments for the penetration of iron plates, that the Whitworth gun has been most successful; *Cox*, J. 529-533; *Alderson* 664; *Taylor* 1508; *Hay* 1856; *Hewlett* 2188; *Whitworth* 4008-4016. Witness gives a detail of various experiments carried on for the purpose of determining the best method of penetrating iron plates; *Harrison*, A. 1401-1444 (*see Analysis of his evidence*). The successful penetration of iron plates depends on the material of the projectile, and the velocity with which it is delivered against the plate; *Harrison*, A. 1414; *Taylor* 1511; *Hay* 1832. 1858; *Gardner* 2724. Statements that muzzle-loading guns give the best promise of success in the penetration of iron plates from their being best adapted to stand heavy charges, and thus give high velocity; *Harrison*, A. 1435; *Hay* 1841; *Hewlett* 2092. 2187. Evidence that flat-headed projectiles do not give greater penetration of iron plates unless the latter be inclined; *Harrison*, A. 1437; *Boyer* 1735; *Hay* 1859-1862. Detail of experiments, for the determination of penetration of projectiles in water; *Liddell* 1075-1087. Further evidence of submarine penetration and example given of the very destructive effect of a shell fired through the bottom of H.M.S. "Griper," and opinion given of the practicability of carrying on submarine warfare; *Hewlett* 2165-2181. Opinion that the 110-pr. Armstrong is unsuited for the purpose of penetrating iron plates; *Gardner* 2614. Evidence of the penetration of masonry, earthworks, and wood by the Armstrong and Whitworth guns; *Alderson* 667-672; *Taylor* 1547-1550; *Harrison*, R. 1893. 1894; App. 158. Witness states that at experiments that he saw of firing against the cupola shield that the penetration of the 68-pr. and 110-pr. Armstrong were nearly alike; *Liddell* 976. Evidence cannot determine why the rapidity of twist should give increased penetration as contended by Mr. Whitworth, and states that it might give a slight push in passing through; *Boyer* 1690. Witness gives his views relative to the best means of penetrating the sides of ships; *Whitworth* 3969-3978.

## PER-CENTAGE:

Per-centage of mechanical failure, at the Royal gun factories Woolwich in the manufacture of the Armstrong guns; *Anderson* 2967. The per-centage of steel barrels found unfit for the Armstrong gun very large; *Noble* 3237-3246. Denial that Sir Wm. Armstrong pays any per-centage or royalty for making use of the steel barrels for his guns; *ib.* 3228. 3247-3249. The value of the steel barrel for the Armstrong guns, is about 50 per cent. in addition to the original steel ingot, turning and boring being included; *ib.* 3309, 3310. 3411-3413. Opinion that the welds in wrought iron have only 50 or 60 per cent. of the strength of the iron in bar; *ib.* 3356. 3364. Statement that the projectiles supplied to the Committee would be 25 to 30 per cent. cheaper if supplied in large quantities; *ib.* 3626. The expense of tools for repairing an Armstrong gun would not add more than 2 per cent. to the expense of it; *ib.* 3648. Evidence of the payment of 2 per cent. to Mr. Whitworth from Messrs. Firth steel makers for using his patent right; *Whitworth* 3733-3747.

PERCUSSION AND PILLAR FUZE. *See* FUZE.

PINS, KEEP. *See* LEVER.

## PIVOT GUNS.

Witnesses state the advantage of the Armstrong gun for use as pivots, on board ship, from their accuracy and great range; *Liddell* 972. 1037; *Rice* 1939. 1942. Evidence that the only disadvantage of the 110-pr. as a pivot lies in the difficulties of loading it; *Liddell* 1037; *Bechervaise* 1209. Witness would prefer a Whitworth gun as a pivot; *Seymour* 2028. Opinion that the weight of a pivot gun should not be more than 5 tons, unless entirely controlled by machinery; *Hewlett* 2083-2085.

POLYGONAL. *See* RIFLING.

## POWDER:

Evidence that Captain Brown's plan of solidifying powder is so satisfactory as to permit of flannel cartridges being dispensed with; *Whitworth* 54.

Witness states that in small guns the size of the grain of powder does not make much difference, but in large guns it is desirable to use powder of a large grain; states also that 2A<sup>4</sup> powder is much more rapid in its action; *Armstrong* 176-179. Statement that when gunpowder is in contact with metal that there is a great deterioration of both, and this disadvantage exists in the Armstrong fuze; *Boyer* 1714-1720. Witness mentions the injury done to the powder in the gas pipe bursters for Armstrong shell; *Bent* 2757. Evidence that with 10 lbs. of the Armstrong powder the Whitworth gun attained a proportionately longer range than with 12 lbs. of the ordinary cannon powder; *Whitworth* 3838-3852. Witness prefers the strongest powder to be used in his gun for the penetration of iron plates, and in consequence applied for the smooth bore powder; *ib.* 4039-4053.

POWELL, RICHARD ASHMORE, CAPTAIN R.N. (*Analysis of evidence*.)

Commanded a vessel with six Armstrong 110-prs. on board; 2225. Only exercised with them twice, and was satisfied with them, with the exception of the vent-pieces breaking twice, and the want of facility in training; 2228. No inconvenience from smoke between decks; 2237. The vent-pieces that broke had not the projection behind; 2239. Considers the Armstrong breech-loader a good gun for a cupola; 2246. In practising in, and firing against the cupola, lost confidence in the Armstrong gun from the breaking of the vent-pieces; 2252. Considers this gun inconvenient, and more liable to injury than a common gun; 2254. As a boat gun, considers the Armstrong gun violent in recoil, and a little more inconvenient than the ordinary gun; 2260. With every appliance to work a broadside gun, sees no objection to a weight of 10 tons; 2266. Could not go beyond the 110-pr. Armstrong as a breech-loader, on account of the vent-piece; 2268. Considered the accuracy of this gun very satisfactory; 2269. It did not cause much loss of time to raise the breech in loading; 2273. Does not consider the recoil of the 110-pr. excessive; 2276. In selecting guns for a ship, would have the majority of smooth-bore and muzzle-loaders, and the minority Armstrong breech-loaders; 2282. Thinks a breech-loader less fatiguing to work, but not so rapid to fire as a muzzle-loader; 2285. No difficulty in handling the vent-piece of 110-pr.; 2289. Have had inconvenience from the tin cup jamming the vent-piece; 2294. A vent-piece stuck in, and we could not get it out; 2305. Does not think the Armstrong projectile good for ricochet firing; 2307. Has found the Armstrong fuzes successful; 2309. Considers the mode of altering the Armstrong fuze an advantage; 2312. Has known no instance where the shot became unserviceable from dents on it; 2314. Considers cupolas, for training and accuracy, are unequalled; 2320.

PRECISION. *See* ACCURACY.

PRICE OR COST. *See* EXPENSE.

## PROGRAMME:

The programme of the Armstrong and Whitworth Committee for the competitive trial of the contending field guns:—For range, initial velocity, and retardation, accuracy, penetration, destructive effects, ease of working, recoil, rapid and prolonged firing, capability of standing rough usage; App. 165, 166.

Sir W. Armstrong's programme, with zinc and undercut projectiles, fuzes, and rapid firing; App. 285-288.

Mr. Whitworth's programme, with rifled spheres, shot and submarine practice; App. 328-331.

## PROJECTILES:

- 1st. Armstrong projectiles.
  - 2nd. Whitworth projectiles.
  - 3rd. Projectiles of other natures.
- 1st. Armstrong projectiles.

Evidence in approval of the Armstrong projectiles; *Cox*, S. 236; *Milman* 856; *Liddell* 1096. 1134; *Milward* 1314; *Taylor* 1537; *Gardner* 2652. Statement of the formidable nature and very destructive effects of the Armstrong shell; *Cox*, S. 295. 355; *Alderson* 711; *Milward* 1353, 1354; *Harrison*, R. 1865, 1866. 1877; *Hewlett* 2174; *Gardner* 2651. Opinions given of the great advantage of having but one form of projectile in the field; *Cox*, S. 257; *Milman* 832; *Liddell* 1133; *Milward* 1364; *Glyn* 1975; *Gardner* 2721. Evidence that the Armstrong projectiles are not easily damaged,



and that in the event of any dents being found upon them they are easily removed; *Cox*, S. 308. 317; *Cox*, J. 552-557; *Alderson* 637, 638; *Liddell* 1098; *Bechervaise* 1286, 1287; *Milward* 1349-1351; *Rice* 1916, 1917; *Powell* 2314. Witnesses state the liability of the old pattern Armstrong shell stripping on being fired; *Cox*, S. 355-361; *Alderson* 582; *Milman* 936; *Taylor* 1566, 1567; *Gordon* 1788; *Glyn* 1972, 1973; *Seymour* 1993; *Hewlett* 2204. Evidence that since the zinc process of attaching the lead has been introduced, that the stripping has been obviated; *Cox*, S. 361; *Alderson* 582; *Taylor* 1566; *Boxer* 1684. 1687. 1739; *Gordon* 1791; *Hewlett* 2204, 2205. The method of attaching the lead coating by means of the tin process was defective, and caused stripping and separation of the metals; *Cox*, S. 408-410; *Boxer* 1680. 1682-1687; *Gordon* 1783-1788. 1792; *Glyn* 1990; *Hewlett* 2204; *Bent* 2758. The stripping of the Armstrong projectiles is of no practical disadvantage; *Milman* 936-939; *Milward* 1383-1385; *Taylor* 1566-1568. Witness observes that the heavier projectiles are most liable to injury, from the liability of their being dropped while being carried; *Cox*, S. 372. Opinion given the projectile for the 110-pr is not satisfactory, not being adapted for firing at iron plates; *Liddell* 1096. Witness mentions the small per-centage of Armstrong projectiles injured by travelling in a field battery subject to examination, and states that the largest proportion injured was six out of 123, all of which by a little hammering were made to fit the bore; *Taylor* 1542. Statement that the shells manufactured with the tin process are to be considered unserviceable, and to be withdrawn accordingly. There are, however, a large number of this nature all over the world by land and sea; *Gordon* 1782, 1783. 1792. Evidence that in some instances, from jolting in the limber boxes, that the bases of the Armstrong shell become enlarged, and that on the change of ammunition of two batteries, that out of 1,486 shells 394 were unserviceable; *Gordon* 1819-1823. Statements that the mode of attaching lead by the undercutting process has proved a failure; *Boxer* 1682; *Bent* 2758. Witness relates the principles which regulate the manufacture of the projectile for the Armstrong shunt gun, and mentions the number of fragments into which 12-pr. Armstrong shell breaks, together with its price complete with fuze; *Armstrong* 147-155. 180-189. Evidence of the advantage of a soft metal coating to rifle projectiles; *Armstrong* 147; *Alderson* 618; *Taylor* 1505; *Hay* 1836. 1838; *Hewlett* 2076. Cost of re-leading Armstrong projectiles by the zinc process about 10l. per 100; *Boxer* 1740. Witness states that the fuze holes of shells made at Elswick were found to have their fuze holes out of the proper centre line of the shell; *Boxer* 1677. Evidence that the inspection of projectiles made at Elswick rests with the Inspector of Artillery, while those made at the Royal Laboratory are inspected in that department; *Boxer* 1679, 1680; *Gordon* 1781. Comparison of the action of a projectile striking an iron plate with that of the explosion of the charge on the gun, both being subject to a strain suddenly applied; *Noble* 3496-3500. Evidence that shot was only supplied for the trial of the 12-pr. Armstrong in consequence of the demand of the Committee, as shell is the projectile best adapted to the gun on service; *ib.* 3614. 3615. The question of the weight of gun to that of the projectile is rather an involved one, as the recoil of the gun carriage has to be considered. In the 9 and 6-pr. Armstrong it is as low as 90 to 1; *ib.* 3622-3625. The cost of the projectiles supplied for the competitive trial are 25 to 30 per cent. higher in price than if the same projectiles were supplied in large quantities to Government; *ib.* 3626. The method of turning the shunt projectile the cheapest form of surfacing; opinion that the Whitworth projectile must first have the corners turned true, and it must then be shaped; *ib.* 3627. The witness is inclined to recommend the lead being attached to the Armstrong projectiles by undercutting, instead of zincing; states that although the latter process may have been found cheaper in the Royal Laboratory, it has not been so at Elswick. Knows no objection to the undercut process, except that projectiles have the lead on the nose of shell sometimes loosened from shaking in the gun limbers; *ib.* 3628-3647. Evidence of the method of putting on the studs on the shunt projectiles, the rule for the number inserted being determined by the pressure required to drive the projectile; *ib.* 3653-3665. Opinion that the shunt projectile is cheaper than the Whitworth. Statement of prices at which the Armstrong projectiles have

been supplied; *ib.* 3670-3675. 3689. Table of weight, material, dimensions, and cost of Armstrong projectiles; *App.* 159, 160. Experiments for penetration of Armstrong and Whitworth projectiles; *App.* 158. (See further competitive experiments.)

## 2nd. The Whitworth projectiles.

Evidence mentions the necessity of two natures of projectiles for the Whitworth gun; *Milman* 849. Statement of objection to Whitworth projectiles, from the shot and shell being of different lengths, thereby causing an irregularity in the ranges; *Taylor* 1535. Witness states, with regard to the Whitworth shrapnel shell, that a very good form has been given to them, by which only a small amount of deflection is caused and a greater range attained than by the form adopted for the Armstrong gun, and considers the results obtained by the Whitworth very satisfactory. Is of opinion that to secure proper bursting of this shrapnel, that two bursting charges should be available to be used according to range, and thus secure a proper spread of the bullets. Believes the Whitworth more effective than the Armstrong segment shell. Observes that the Whitworth shot would be shorter than the shell, and is of opinion that shot of different lengths may be fired from the same gun if sufficient twist be given, and mentions that the cost of the Whitworth shell is less than the Armstrong. Recommends the use of the Whitworth shrapnel as shot, shell, or case shot, it not being safe to fire the ordinary case from a Whitworth gun; *Boxer* 1570-1576. 1590-1600. 1602-1606. 1667. 1691-1693. 1732. In connexion with the above, see the correspondence of Sir Wm. Armstrong, Mr. Whitworth, and Colonel Boxer, *App.* 204. 207. Evidence that the friction of the hard surface of the projectile in the Whitworth gun is detrimental to the lasting properties of the gun; *Hay* 1836. 1838. 1848, 1849; *Hewlett* 2050. 2076. 2093. 2190. Opinion that the friction of hard surfaces is no injury to the bore, and that the Whitworth projectile is therefore preferable from not requiring lead coating, which is so liable to deteriorate; *Anderson* 2472-2476. 3002. 3142-3144. Witness mentions the necessity of using a sabot to prevent the Whitworth shot slipping forward in the gun; *Hay* 1850. Witnesses state that the shell arrangement of the Whitworth gun is not good, and not to be compared to the Armstrong in its present state; *Cox*, J. 559; *Taylor* 1537; *Isacke* 2853; *Best* 2895-2903. Evidence gives the rule for determining the size of the Whitworth projectile, and states that a gun of proportionately larger bore should be used for shell firing; *Whitworth* 27. 46-48. 76. 114. Statement of the principle recommended for the Whitworth projectiles would be relatively small diameters, and for the shell five diameters in length if sufficient rotation could be attained; *ib.* 3969-3974. Opinion that the cost of projectiles is of much greater importance than that of the gun, from the large consumption of the former in comparison with the number of guns worn out in the service; *ib.* 3810. 3994. 4065. 4096. The element of time the best means of comparing the cost of projectiles according to the two systems, the cost of the material can afterwards be added; *ib.* 3994-4005. Evidence of the first experiments with steel projectiles for penetration of iron plates, and the success attending Mr. Whitworth's shell fired against the "Trusty;" *ib.* 4008-4016. 4098-4100. Witness would undertake to supply the Whitworth projectiles in any quantity, simply cast without any tooling, but states it would be better to tool, which costs 5d. per dozen for the 12-pr. shot; *ib.* 4022-4026. For details of the weights, material, and dimensions of the Whitworth shells, &c.; *App.* 161. For the penetration of iron plates by Whitworth projectiles. (See PENETRATION.)

## 3rd. Projectiles of other natures.

Evidence that the general effect of molten iron in shells is not very great; *Alderson* 678; *Milman* 859; *Taylor* 1563. Opinion that the effect of grape and case at short ranges is better than the Armstrong segment shell; *Powell* 2043, 2044; *Hewlett* 2193. Evidence that the amount of retardation to a projectile depends very much upon the form of its head, and that the retardation of a rifle shot is much less than a smooth-bore; *Milman* 750-753.

FOR FLAT-HEADED PROJECTILES. See PENETRATION.

PROOF. See INSPECTION and PROOF.



## R.

## RANGE:

Evidence of the excellence of range attained by the Armstrong gun; *Cox*, S. 230; *Cox* J. 415; *Milman* 726-729. 737; *Liddell* 944; *Bechervaise* 1196, 1197; *Milward* 1311. 1330; *Rice* 1904; *Hewlett* 2049; *Gardner* 2602. Statements of the ranges obtained by the Whitworth guns, and mention made of their exceeding the Armstrong in accuracy and extent of range; *Cox*, J. 500. 521; *Alderson* 623. 706; *Milman* 735; *Seymour* 2029; *Hewlett* 2051. Witness mentions the range of Whitworth guns tried at Shorncliffe as differing very much from each other; *Best* 2901-2903. 2927-2930. 2938-2942. Evidence of the effect on range and deflection, obtained by the tapering form of shell adopted by Mr. Whitworth, giving with 10 degrees of elevation 500 yards more range than an Armstrong projectile under the same circumstances; *Boxer* 1570. Mention of the effective fire of the Armstrong gun in China at a long range; at 2,000 yards the effect on the enemy was most destructive; *Milward* 1320. Evidence of the ranges obtained at Shoeburyness and at Southport with the 70-pr. Whitworth, with the slow burning Armstrong powder, and with the ordinary smooth-bore powder; *Whitworth* 3838-3853. 4044-4050. Instances given of ranges with various Whitworth guns; *ib.* 1. 6-8. 13. 67. 74. Statement that the Whitworth 9-inch gun at 2,000 yards will send a shot through the side of any ship afloat; *Whitworth* 3969.

## RAPIDITY OF FIRE. See FIRE.

## RECOIL:

Witnesses state that recoil determines the weight of a gun; *Armstrong* 201; *Whitworth* 3837. The recoil of the 20-pr. Armstrong shortened gun is very great; *Cox*, S. 379-382. The short 20-pr. Armstrong gun, when mounted temporarily on a 32-pr. howitzer carriage, did not have an excessive recoil; *Alderson* 611. The 12-pr. Armstrong gun has a very sharp recoil; *ib.* 639. The recoil of the 40-pr. Armstrong is very little more than the 8-inch gun; *Liddell* 1159. Witness states his opinion that the recoil of large guns on board ship may be met thoroughly by the adoption of Captain Cowper Coles's system, there being only a limit to the number of guns carried; *Hay* 1854. The recoil of the 110-pr. Armstrong is sharper than the 68-pr. of 95 cwt., but still perfectly controllable; *Rice* 1934. Witness states the recoil of the 20-pr. Armstrong boat gun is violent, but still prefers it to the 24-pr. howitzer. The recoil of 110-pr. Armstrong is sharper than the corresponding smooth-bores, but it must be recollected that the weight of the gun is comparatively less, consequently the strain upon the breeching and bolts is less; *Hewlett* 2214. 2285. Evidence thinks the 12-pr. Armstrong is a little violent in its recoil; does not consider the recoil of 110-pr. intense, as compared with that of the smooth-bore of same calibre; *Powell* 2259. 2275. A certain weight is required in the gun as regards recoil, and by having recourse to mechanical means the recoil may be kept within bounds; *Anderson* 2424. 3153. Statement that the question of recoil enters into the weight which should be given to a gun, as compared with the weight of the projectiles; *Noble* 3622-3624.

## RE-LOADING PROJECTILES. See COATING.

## REPAIRS:

Witness states that the concussion fuzes of his battery were very much injured, but he repaired them with the aid of the civil artificers attached to the battery, and mentions that everything in the battery that wanted repair could have been done with the men of the battery; *Milward* 1390, 1391. 1399. Evidence states that tools for the repair of Armstrong guns are issued by him, which are extremely complicated; *Gordon* 1755-1758. Statement that the repair of the Armstrong guns necessitated the carrying of complicated tools, and required trained artificers; *Gardner* 2667. Mention made of the ease with which an Armstrong gun was repaired on board the "Excellent," in which four shells had burst and injured the rifling; *Hewlett* 2049-2051. The difficulties of repair much increased by the introduction of the wedge gun, which is not so easy to repair as the screw breech-loader; *Anderson* 2558-2573. Evidence that of three wedge guns tried at proof, two required repair afterwards; *Gordon* 1772. Statement of the number of Armstrong

guns issued, and afterwards returned to Woolwich for repair; *Gordon* 1748; *App.*, 167-200. All minor repairs are performed at the stations where the guns are situated; *Gordon* 1752. Detail of tools required for keeping in repair Armstrong guns; *Gordon* 1794; *Noble* 3648; *App.*, 162-164.

## RETARDATION:

It would appear reasonable to infer that when the initial velocities are nearly the same the greatest range would necessarily experience the least retardation. The retardation of a rifled shot is comparatively much less than a smooth-bore; and the difference of retardation depends very much on the shape of the head of the projectile; *Milman* 750-753. Experiments to ascertain the retardation of the projectiles fired from Armstrong and Whitworth competitive field guns; *App.* 368, 370, 371.

## RETURNS:

Tabular statement or return of each description of Whitworth gun with projectiles and full detail; *Whitworth* 112; *App.* 161. Return of all descriptions of Armstrong's guns manufactured; *App.* 159, 160. Return of facing implements supplied for each nature of Armstrong gun; *App.* 162. Return of special tools supplied for, and spare articles allowed for Armstrong guns; *Gordon* 1794; *App.* 163, 164. Return of the number of Armstrong guns manufactured at Woolwich and Elswick; *App.* 164, 165. Return of examination of four brass Whitworth 12-pr. guns after firing 200 rounds at Shorncliffe; *Best* 2891; *App.* 165. Return of Armstrong guns issued up to 1st August 1863, showing the number of rounds fired, the station to which they were issued, with cost of alteration or repair as far as is known at Woolwich; *App.* 167-200. Returns of examination of competitive 12-pr. Armstrong and Whitworth guns; *App.* 202, 231-235. Return of examination of experimental fuzes, lubricators, 70-pr. shells, &c., travelled for 20 days in a Flanders waggon; *App.* 243, 244.

## RICHARDS, WESTLEY. See BREECH-LOADERS.

RICE, EDWARD CAPTAIN, R.N. (*Analysis of evidence.*)

Commanded H.M.S. "Algiers," had on board one 110-pr. and two 40-prs. Armstrong guns; fired 32 rounds from them, the practice was very good; 1904. No accidents occurred; 1905. The men preferred muzzle-loaders from the feeling of a sense of insecurity about breech-loaders, and the latter are slower at loading; 1909. Less danger in loading breech-loaders, but in firing them they are more liable to accidents than muzzle-loaders; 1915. Observed no injury to, or inconvenience with the Armstrong projectiles; 1916. Weight of vent-piece in 110-pr. a cause of slowness in loading; 1919. Found the fuzes all right; 1924. Would prefer a muzzle-loader; 1927. No inconvenience from the recoil of an Armstrong gun; 1931. Liked the 40-prs. very much, preferred them to the 32-prs. of 45 cwt.; 1935. Believes the element of accuracy not so important at sea as on land; for naval purposes a heavy blow at short distances the main object; 1940. Would prefer the 68-pr. to the 110-pr. Armstrong, as a broadside gun; but the 110-pr. as a pivot gun.

## RIFLED GUNS:

Evidence states that where the same weight of projectiles and charges are used, that the effect of the rifled gun is greater against iron plates than the smooth-bore; *Armstrong* 164. A very trifling difference in rapidity of fire between a muzzle-loading and breech-loading rifle gun; *Cox*, S. 291. Witness considers that the rifled gun is one which has given the greatest range when compared with the smooth-bore; its accuracy meets every requirement; *Milman* 725. 764. Evidence states that whichever of the rifled guns has the most enduring power, and carries the heaviest charge, thus giving the greatest velocity, is the gun that will effect greatest injury on iron armour plates; and witness prefers the rifled gun for the broadside; *Hay* 1832-1840. Witness would prefer the Whitworth as a rifled pivot gun, and prefers the smooth-bore to the rifled gun for the broadside, and mentions the bursting of two rifled cast-iron guns on board the "Lynx" at Kinburn; *Seymour* 2028. 2031. 2033. Evidence would not propose to arm ships entirely with rifled guns, and would only have a proportion for special purposes; *Hewlett* 2149-2151. Witness mentions an instance



where in firing and manœuvring rapidly with a 9-pr. gun and 24-pr. howitzer against an Armstrong gun, that the effect of the smooth-bore was rather better than the rifled gun, the men and officers being hurried in both cases; but in a question of range the rifled gun is unquestionably superior; *Gardner* 2701. Statement that a shot has more chance of sticking in the bore of a rifled gun than in a smooth-bore; *ib.* 2687. Evidence is in favour of rifled guns, for certain circumstances, and alludes to the impression, both in America and Prussia, that a certain proportion of smooth-bores would be useful, and is inclined to have smooth-bore and rifled guns in separate batteries, half of each, the feeling in Prussia and elsewhere was that about one-third rifled guns was the best proportion; *ib.* 2729, 2730. Witness mentions the rifled gun as best for breeching batteries at long ranges, and gives instance of the importance of the rifle gun for siege operations; *ib.* 2745-2749.

#### RIFLING :

Evidence of the pitch of rifling for the Whitworth guns; *Whitworth* 39-44. 3982; *App.* 161. Witness describes the object of the shunt rifling, and gives twist for 300-pr. and field guns; *Armstrong* 147. 168. 190. 191. Witnesses mention the injury to the rifling of a brass 12-pr. Whitworth gun at Shoeburyness; *Cow*, S. 303; *Alderson* 619; *Taylor* 1498. The bursting of shells in Armstrong guns does no serious injury to the rifling; *Alderson* 618. 701. 702; *Liddell* 1128; *Milward* 1387; *Taylor* 1504; *Hewlett* 2049. Opinion that the bursting of a shell in a Whitworth gun would not seriously injure the rifling; *Bower* 1694. The projectiles from heavy guns sometimes strip, and do not take the rifling if the guns are not properly run up; *Alderson* 652. Opinion that the rifling of the Whitworth gun would not cause any great strain from the rapidity of the twist; *Bower* 1657, 1658. 1689. Witness mentions the experiments at Woolwich trying the effect of torsion on various systems of rifling; and states that whatever kind of rifling is adopted that the projectile should always have a soft coating to preserve the gun; *Hay* 1836. Witness mentions deposit from fouling in the angles of the Whitworth gun; *Hewlett* 2099. 2105. Evidences have no confidence in the severe rifling twist in the Whitworth gun; *Cow*, S. 300; *Hewlett* 2190. Evidence gives the amount of torsional resistance of the Lancaster, Armstrong, Scott, and Whitworth's systems of rifling, and mentions that there is very little tendency to burst in the 10-grooved Armstrong shunt gun; *Anderson* 2480-2483. Witness does not consider there is any danger from the rapidity of twist in the Whitworth gun; *ib.* 2485. Evidence is strongly against the shunt mode of rifling; it is difficult to manufacture, and considers it is not simple enough, and is of opinion that any incline will cause the projectile to twist to a centre; *ib.* 2584-2596. Statements of the wearing of the rifling of certain brass 12-prs. after practice; *Isacke* 2836; *Best* 2891; *App.* 165. The witness of opinion that with the hexagonal rifling of Mr. Whitworth, if the bore should happen to be made of wrought iron, it would be much injured if a shell burst in it; *Anderson* 3016. If the projectile leave the bore a steady fit, and is long enough to take its direction from the bore, and has whirl enough to keep it up, it will be accurate in whichever way these conditions are accomplished; *ib.* 3171-3176. If it were a question between the shunt rifling and the Whitworth, the witness would prefer the Whitworth. The Armstrong multi-grooved gun is the easiest of all other to rifle; *ib.* 3179-3183. 3203-3207. Witness states that the cost of any kind of rifling is trifling compared to that of the gun; *Noble* 3606-3608. Rule stated for the grooves in the rifling of the 150-pr. 300-pr. and 600-pr. Armstrong shunt guns, to be 6, 8, and 10 each respectively; *ib.* 3663. For the pitch of rifling for the Armstrong and Whitworth guns, see tabular statement; *App.* 159-161. Witness maintains there is no system of rifling as cheap as the polygonal system; *Whitworth* 4094.

#### ROTARY MOTION :

Statement that by diminishing the charge a very long shell may be fired from the Whitworth gun by giving plenty of rotary motion; and the Whitworth guns have double the rotary motion of other guns; *Whitworth* 35-37. 3969-3974. As long as the requisite rotation is given, it does not appear to make any

difference whether you give it by grooving or polygonal sides. Certain projectiles require a particular rotation, and it is a matter of indifference how it is given; *Armstrong* 164; *Anderson* 3171-3176. The velocity of rotation is very different in the Armstrong and Whitworth guns; *Milman* 749; *Bower* 1606.

ROUGH USAGE. See ENDURANCE.

#### S.

#### SAFETY :

- 1st. Of the Armstrong gun.
- 2nd. Of the Whitworth gun.

##### 1st. Armstrong gun.

Witness states that a properly manufactured Armstrong gun would be found impossible to burst, no matter what is done to it; *Armstrong* 136. Evidence is of opinion that if the vent-piece was made indestructible, that the Armstrong gun might be regarded as perfectly safe; *Cow*, S. 401; *Liddell* 1121; *Hewlett* 2158. Opinion of the feeling of safety from bursting, of the Armstrong gun; *Cow*, J. 415. Evidence that the coil system of manufacture gives very great confidence and security; *Alderson* 721; *Liddell* 1148; *Taylor* 1524. 1531; *Hewlett* 2157; *Anderson* 2377. 2412; *Gardner* 2718, 2719. Mention of the safety of the Armstrong gun and the contrary of the Whitworth; *Noble* 3463-3471.

##### 2nd. The Whitworth Gun.

Evidence of the safety of the Whitworth gun from the strength of its construction, and statement that the steel hoop is twice or three times as strong as the wrought-iron hoop; *Whitworth* 3830-3836. Evidence of the confidence felt in the 9-inch, and that a Whitworth gun of any size may be made of good material; *ib.* 3960-3968.

#### SEVENTY-POUNDERS. ARMSTRONG AND WHITWORTH GUNS.

Witness mentions the first 70-pr. Armstrong made had the movement of the wedge breech-closing arrangement from the side, from which an escape of gas took place, but afterwards it was entirely obviated by improvements made; *Armstrong* 126. Description of the shell for the 70-pr. Armstrong shunt gun; *ib.* 180. Evidence mentions the difficulty of loading the 70-pr. Whitworth gun, and states that the 70-pr. Armstrong is better than the Whitworth, but the range of the latter was somewhat the longest. Gives opinion favourable to the 70-pr. Armstrong side-loading gun, and, as an instance of the rapidity of fire attainable with it, 50 rounds were fired in 32 minutes and 32 seconds. Has also seen good practice with the Armstrong 70-pr. shunt gun; *Cow*, J. 495-503. 539-543. 568-573. Witness thinks that the side-loading arrangement of the 70-pr. is good; *Alderson* 597. Evidences contrasts the initial velocities and charges of the 70-pr. Whitworth and Armstrong guns; *Milman* 745-748. Evidence of the performance of the 70-pr. Whitworth gun against iron plates at Shoeburyness; *Harrison*, A. 1410. Statement of a 70-pr. Whitworth gun that was used against iron plates at Shoeburyness having been made on the coil principle; *Taylor* 1528. Witness states that 100 70-prs. were being constructed at Elswick; and mentions the giving way of the side-loading arrangement of a 70-pr. Armstrong gun; *Gordon* 1763. 1772. Evidence favourable to the 70-pr. Armstrong wedge gun, and considers it safer than the vent-piece principle, and well adapted for ships; *Hewlett* 2077, 2078. Statement that steel barrels were first introduced for 70-pr. Armstrong guns towards the end of 1862; *Noble* 3277. The steel from the Bessemer process might be adopted for guns of sizes up to the 70-pr.; *ib.* 3290. Preference for the 70-pr. with steel tube over the 70-pr. with coiled tube; *ib.* 3315-3318. Peculiar construction of the breech screw plug, and superimposed coils; *ib.* 3574-3580. Cost of the finished barrel of 70-pr., 210*l.*; *ib.* 3594. The breech-loading 70-pr. Armstrong gun was made 15 cwt. lighter than the muzzle-loading 70-pr., as the former was intended for a shell gun; *ib.* 3614-3621. Witness states that the 70-pr. Whitworth at Shoeburyness with 10 lbs. of powder attained a range nearly equal to that when a charge of 12 lbs. was used; *Whitworth* 3838. The competitive 70-pr. has the hoop next over the barrel in three layers, put on as one hoop, at the same time the succeeding hoop also in three, the trunnions



screwed on and an extra hoop, in consequence of the vent being from above; *ib.* 3911-3921.

SEYMOUR, FREDERICK BEAUCHAMP, C.B., CAPTAIN R.N. (*Analysis of evidence.*)

Commanded naval brigade in New Zealand, the practice not satisfactory from the 12-pr. Armstrong guns; do not think it was more accurate than the firing from the 9-pr. brass guns; observed some shot strip very much; 1993. An accident occurred in the "Harriers" boat by the vent-piece coming out, and injured eight men; 1995. Tried, but could not hit a sap roller at 750 yards with either a 12-pr. Armstrong or an 8-inch gun; 1996. The great objection to the Armstrong gun is the quantity of gear and screws about it. Could not land it uninjured on a beach in a heavy surf; 2000. Coehorn mortars more effective than 12-pr. Armstrong in turning the enemy out of the rifle pits; 2,008. Thinks that confidence has not been gained in the Armstrong gun from the experience in New Zealand; 2014. Would prefer a muzzle-loader to a breech-loader; 2015. Thinks that the smoke which comes from the breech when the vent-piece is taken out a great objection between decks; 2016. Do not think the 12-pr. Armstrong a good boat gun; 2018. If allowed the choice in fitting out a ship, would not have an Armstrong gun on board; 2027. Would prefer the Whitworth gun for a pivot, but not as a broadside gun; 2028. For the broadside prefers the smooth bores, from the great rapidity in the loading; 2031. The advantage of the smooth-bore howitzer is the possibility of firing grape and case with it, and for this purpose is superior to a fire with segment shell; 2044.

SHELL GUN. *See* HOWITZER.

SHOT, SHELL, AND SHRAPNEL. *See* PROJECTILES.

SHRINKING. *See* COIL AND STRENGTH.

SHUNT GUN. *See* MUZZLE-LOADERS.

SIGHTS:

Statement that if the sights of the Armstrong gun were shot away, that as good practice would be made as with the 12-pr. smooth-bore, and there would still be the ratchet sights to fall back upon; *Cox, S.* 289, 290. Witnesses state that in sending the Armstrong guns away in boats, the sights would be taken out until mounted in the boat; *Liddell* 1038-1040; *Becher-vaize* 1247-1265. Evidence mentions that if the side sight of an Armstrong gun be shot away, that there is still the middle line of sight to fall back upon; *Milneard* 1493. Witness of opinion that although the Armstrong sights are admirably adapted for certain special purposes, yet they are not simple enough for ordinary service; *Gardner* 2656. Letter relative to the adjustment of the sights of the competitive Armstrong and Whitworth guns; *App.* 209.

SIX-FOUNDER ARMSTRONG AND WHITWORTH GUNS.

Evidence proposes the 6-pr. Whitworth gun, and mentions certain particulars regarding it; *Whitworth* 1. 10-14. 23. 25. 45. 62, 63; *App.* 161. Statement of the dimensions and weight of an Armstrong 6-pr.; *App.* 159, 160. Average per-centage of failures in the manufacture of the 6-pr. Armstrong; *Anderson* 2967.

SIX HUNDRED-FOUNDER ARMSTRONG GUN:

Witness is of opinion that it will require a large gun, such as the 300 or 600-pr. to do any damage to iron-plated ships; *Alderson* 662. Evidence mentions that the tempering of such a large mass of metal as the shot for a 600-pr. would cause it to become brittle and "fly;" *Noble* 3398. Mention of the number of grooves in the 600-pr. Armstrong to be 10; *ib.* 3663. The value of the steel barrel for the 600-pr. is 600*l.* before anything is done to it; *ib.* 3708. Dimensions, weight, and other particulars of the Armstrong 23-ton or 600-pr. gun; *App.* 159.

SIXTY-EIGHT-FOUNDER SMOOTH-BORE GUN:

Evidence states that it is easier to work the 68-pr. than the 110-pr. Armstrong; *Cox, S.* 383; *Alderson* 648; *Milman* 804; *Rice* 1911. 1919. The penetration of the 68-pr. and the Armstrong 110-pr. against the cupola shield were nearly alike; *Liddell* 977. Witness states that it is not usual to carry guns so heavy as the 68-pr. on the broadside of a ship, but is of opinion that it will be necessary to have them to contend against iron-plated ships; *Hay* 1841. The evidence prefers the 68-pr. to the 110-pr. Armstrong for

a broadside gun; *Rice* 1942. Witness states the 68-pr. was the best gun on board the "Miranda," and considers that nature of gun to be preferable to any other; *Seymour* 2022-2027. Evidence would prefer the 68-pr. for contending against iron-plated ships at short ranges; *Gardner* 2704.

SMOKE:

Evidence complains of the amount of smoke which escapes from the Armstrong gun when the vent piece is taken out, and considers it an objection on board ship; *Seymour* 2016. Witness has not found the slightest bad results from the smoke from the Armstrong guns in the "Excellent," and considers it to amount to no more than with a smooth-bore; *Hewlett* 2210, 2211. Evidence felt no inconvenience from the smoke from Armstrong guns on board the "Defence;" *Powell* 2237.

SMOOTH-BORE GUNS:

Witness claims his rifle gun to be a smooth bore; *Whitworth* 92. Preference expressed for the smooth-bore instead of the rifle gun for the broadside, from the greater rapidity of loading possible with it; *Seymour* 2031-2032. Evidence prefers the smooth bore for the broadside; would recommend a proportion of rifled guns for special purposes, but the majority should still be smooth bores; *Hewlett* 2151. Witness would take for the armament of a ship the majority of smooth bores and muzzle-loaders, and the minority of Armstrong breech-loaders; *Powell* 2282. Evidence would be inclined to recommend the armament of field artillery to consist of half smooth bores, half rifled guns, to be kept in distinct batteries; *Gardner* 2730.

SOFT METAL. *See* FRICTION.

SOLID FORGINGS. *See* FORGINGS.

SPONGES:

Witness mentions that, in order to test the Whitworth gun, he fired without sponging; recommends that the sponge head for a rifle gun should turn on a pin; *Bower* 1652-1654. 1736. Evidence states that there is a difficulty in getting the sponge into the angles of the rifling of the Whitworth gun; and having seen the sponges with revolving heads used in the "Excellent" is of opinion they do not answer; *Hewlett* 2061. 2101-2103.

STEEL AND HOMOGENEOUS METAL:

Statement that homogeneous metal is only another name for steel having very much less carbon in it than ordinary steel; and description of its manufacture at Messrs. Firths' works; *Anderson* 3092-3096. Evidence of the first Armstrong gun being constructed with a steel barrel, which method is still preferred if steel of good quality could be procured, and the manufacture of the inner tubes of wrought iron has been caused by the difficulty of providing steel of a reliable, and even strength; mention of the improvement in the quality of steel and the advantage of using it for the barrels of Armstrong guns; *Armstrong* 123-125; *Anderson* 2408, 2409. 2418-2428. 3088; *Noble* 3271-3277. 3323. Witness has great confidence in the strength of the Whitworth guns made of homogeneous metal; *Hewlett* 2190. Evidence that the Armstrong firm pay no patent right for using steel barrels for their guns, and denial by the steel makers that they pay Mr. Whitworth any royalty on the use of steel for the barrels of guns; *Noble* 3228. 3247-3249. The steel ingots for the barrels of Armstrong guns are supplied by the makers solid; great care is taken in testing the quality of the steel, and a large per-centage are rejected from the flaws and cracks to which this metal are subject. The testing takes place before the barrels are bored, but even after boring barrels are sometimes rejected for flaws; *ib.* 3228-3238. 3252-3256. The defects in steel increase very much in large masses; in consequence of which the rejections of the barrels the 150 and 300-prs. is very much greater than the 12-prs.; *ib.* 3241-3246. Witness expresses doubts that the uncertainty in the manufacture of steel will ever be removed, and states that the mildest description he has seen has not been capable of resisting percussive action equal to wrought iron, and therefore is of opinion it will never equal that metal for the exterior of guns, but considers that the improvement in steel will permit of its being safely used for barrels; *ib.* 3327-3337. 3510-3513. All experience goes against the belief of witness that



steel should be better than wrought iron for the exterior of guns, mention of the failure of Whitworth guns supplied to Egyptian and Danish governments; *ib.* 3466-3471; *Anderson* 2425. 2426. The use of steel in the solid form is being given up by all governments for guns, and mention of the failure of the Krupp gun made with a large barrel and superimposed steel coils; *Anderson* 2412-2415; *Noble* 3515-3518. The tempering of steel in oil increases its hardness and toughness; its effect upon vent pieces has been greatly to add to their strength and safety, rendering them able to bear heavy blows without breaking. The working of the process is determined by the practical knowledge of the men employed; the evils of tempering in large masses are greater than the advantages to be gained; when barrels get crooked in tempering it denotes a want of homogeneity in the metal. If a 600-pr. shot were tempered and fired against iron plates it would be sure to "fly" from the tension existing in the mass; *Anderson* 3018-3034; *Noble* 3374-3401. Witness states that Messrs. Firth, steel makers, agreed to pay them a royalty on the steel barrels made by them of 2 per cent.; *Whitworth* 3733-3747. The steel barrels for the Whitworth gun are sometimes cast hollow and sometimes solid, and when received are subjected to a hardening and tempering process; *ib.* 3760-3772. The proportion of steel ingots rejected for the Whitworth guns is small; *ib.* 3788. The strength of the steel material of the Whitworth gun is two or three times as strong as wrought iron, and witness considers that if guns are required to stand large charges wrought iron would not stand as well as steel; *ib.* 3833-3836. 3942. Statement that there was no failure of the guns supplied to the Egyptian Government, and that the Danish gun made by Mr. Whitworth burst from too much air space behind the projectile; *ib.* 3876-3889. Opinion of evidence that the manufacture of steel has arrived at such perfection that there is no limit to the size of Whitworth gun that may not be made, and considers a gun with three feet bore may be constructed; *ib.* 3960-3966. Evidence of the success of projectiles made of homogeneous metal, when fired against iron plates; *Harrison, A.* 1410-1412; *Whitworth* 4008-4016. Opinion that percussive action is not injurious to steel in a gun if it is properly tempered; *Whitworth* 4105-4107.

#### STICKING OF SHOT IN THE BORE:

Witness allows that the shot were liable to stick in the bores of the first guns made by him; *Whitworth* 84. Evidence of an instance of a shot sticking in the bore of a Whitworth 12-pr. brass gun; *Cox, S.* 301-306; *Cox, J.* 506; *Alderson* 619; *Taylor* 1498-1500. Witness in practising with Whitworth guns has never seen shot stick in the bore; *Boxer* 1646. Statement of the difficulty of getting the shot home in a Whitworth gun, and mention that the jolly boat's mast with ropes attached were used with a number of men to bump it home; *Hewlett* 2072.

STORK, H.M.S. *See* ACCIDENTS.

#### STOWAGE:

Evidence of the stowage required for the Armstrong gun on board ship for the ammunition, and opinion given that if the 40-pr. Armstrong and 32-pr. smooth bore be compared, that the rifle gun will not require more stowage for its ammunition than the other; *Liddell* 1187-1191; *Bechervaise* 1281. The Armstrong projectiles require greater care in stowage than the round shot, but not than the grape and case; *Bechervaise* 1284.

STRAIN. *See* STRENGTH.

#### STRENGTH OF, AND STRAIN ON GUNS:

Evidence states there may be some particular Armstrong guns defective, but as a general rule there is an abundance of strength in them; *Armstrong* 135. Witness gives his opinion that although the rapidity of twist in the Whitworth gun may wear the bore, yet the gun will stand an immense number of rounds; it may give increased strain, but that does not matter when the gun is of wrought iron, steel, or brass; *Power* 1658. 1688. Evidence alludes to the strains which various systems of rifling have been found capable of sustaining by experiment; *Hay* 1836; *Anderson* 2480. Witness gives the circumferential strength of the wrought iron coils of the Armstrong gun as 25 tons per square inch, and longitudinally it varies from 10 to 14. The solid forged

wrought iron tube has a strength of about 22 tons in both directions; *Anderson* 2350-2363. Evidence that if careful measurement be maintained that there is no doubt about the amount of strain put upon the coils of the Armstrong gun; *ib.* 3077-3081; *Noble* 3547. Statement of abundance of strength in the Armstrong gun to withstand a very good "pinch"; *ib.* 3168. Opinion that Mr. Whitworth ventures a great deal in giving his guns such a rapid twist, but thinks them strong enough to bear it; *ib.* 3181-3183. Witness mentions that for strength in the Armstrong gun the chief dependence is placed on the coils outside; *Noble* 3300. The strain to which the coils are subjected, in the Armstrong gun, is a tensile strain percussively applied; it is well known to persons acquainted with iron that tensile strength is no test for fitness to withstand percussive strain; *ib.* 3484-3498. Mentions Mallet's investigations, would consider wrought iron better than cast, from the "constant" so to speak being high. Therefore wrought-iron guns may be expected to last longer than cast, and steel better than iron, yet they both have the same defects from flaws, and the outer layers add little to the strength of the gun; *ib.* 3528-3530. Witness mentions that the process of hardening and tempering the barrels for the Whitworth guns adds 50 per cent. to the strength of the metal; *Whitworth* 3801. The strength of the steel for the Whitworth gun is two or three times as strong as any wrought-iron hoop, and witness contends that a gun made of wrought iron will be unable to stand the strain of heavy charges, and that steel must be used for guns requiring great strength; *ib.* 3833-3836. 3941, 3942. 4063-4065. Opinion that percussive action is not injurious to steel or homogeneous metal, if it is properly tempered; *ib.* 4105-4107.

STRIPPING. *See* PROJECTILES.

STUDS FOR PROJECTILES. *See* PROJECTILES.

SUBMARINE OPERATIONS. *See* PENETRATION.

#### T.

TAPPET RING. *See* LEVER.

TAYLOR, ARTHUR J., COLONEL R.A. (*Analysis of evidence.*)

Has carried on no experiments with the Whitworth gun except against iron plates, and a trial of the rapidity of fire between them and the Armstrong; 1480. The trial was in favour of the Armstrong gun, that of the Whitworth being unsatisfactory in consequence of delay; 1481. Mr. Whitworth has now remedied these defects; 1482. Believes the fire of Mr. Whitworth's brass muzzle-loader to be slightly more rapid than the Armstrong breech-loader; 1485. Considers breech-loading guns best adapted for the field. If the vent-piece can be guaranteed, would not ask for more. Considers neglect has been the cause of the majority of accidents with vent-pieces; 1487. The caution of the man in loading only required with the breech-loader, and no liability of accident from neglect of the man who sponges; 1488. thinks it would take less time to clean an Armstrong gun ready for action than a muzzle-loader, if they had both been upset into mud; 1491. The contingency of the lever being shot away the only serious objection to the Armstrong gun; 1493. Prefers the rifling of the Armstrong to the Whitworth gun, as should a shell burst in the latter it would prevent further loading; 1498. Bursting a shell in the Armstrong gun does not disable it; 1504. The greatest penetration of iron plates has been attained by the Whitworth muzzle-loading gun; 1508. These guns have been fired with very heavy charges and projectiles of totally different material from the Armstrong; 1511. The proportion of charge for the Whitworth gun is too great for the Armstrong, from the relative weight of the guns; 1512. Considers it an unfair test of a gun to fire it with a larger charge than that for which it was constructed; 1522. Has not seen a Whitworth gun injured except that mentioned; 1525. Mr. Whitworth's two guns used against iron plates were on the coil principle; 1528. Not having seen a Whitworth gun fail, as to the matter of its construction, has no fault to find with it. Thinks the mode of the construction used for Armstrong guns sound, reasonable, and calculated to give confidence; 1531. Believes the Whitworth gun perfectly safe; 1534.



As a solid shot does not object to the Whitworth projectile, but as a shell, it is not to be compared to the Armstrong in its present state; 1537. There would be an economical advantage in using the common fuze with the Whitworth shell, but they would not be less liable to deteriorate; 1539. Gives instances of rapid firing from different guns. The only instance seen of difficulty in loading with lead-coated projectiles was at Portsmouth, when six out of 123 would not go into the gun; but it did not take more than a minute with a hammer to make the projectiles all right; 1542. Has found the old pattern Armstrong time fuze deteriorate considerably; 1545. In firing rifle shot against masonry and earth-works, they turn continuously to the right after striking; 1547. Gives instances of penetration of masonry; 1549. Refers Committee to tabular forms contained in the "Report on Ordnance," 25th July 1862, pp. 155 to 177 and 267, for ranges and initial velocities of the guns under consideration; 1551. We have instances of Armstrong guns which have been in constant work, and fired considerably over 3,000 rounds, and are still quite serviceable; 1552. Has had no accidents with these guns except the breaking of vent-pieces, and the bursting of the 150-pr. smooth-bore gun: attributes that to having tried it beyond its strength with increasing charges; 1555. In the manufacture of this gun an error was made in the position of a safety-valve, intended to relieve it of some pressure from the gas. More strain was consequent than was intended; 1557. The effect of the molten iron shell from the Armstrong gun not very great, no difficulty with the lead from melting; 1563. The new pattern Armstrong projectiles do not strip. Believes that the effects of this stripping in the old shot was exaggerated. Could never trace the flight of a piece of lead beyond 100 yards; 1566. The fragments were very small; 1568.

#### TEMPERING

Witness states that the new method of toughening the vent-pieces in oil has been highly successful, and that the difference between the raw steel vent-piece and that subjected to the tempering process is enormous, as tested by blows; *Armstrong* 207. By the method of tempering steel in oil the tenacity is increased 20 per cent., and still more its power of resisting compression, and you nearly double the tenacity, at the same time there is much to learn in the practice of it, from the heat of the oil being required to be a particular temperature; *Anderson* 3018. Not necessary to temper the steel barrels after the form is given to them, as they can be turned afterwards, and pressed home by 2,000 tons pressure. The process of tempering is a very simple matter and long used; witness does not think there is anything in the oil by itself, but in the crystallization which is due to the rate of cooling, and fully describes the manner pursued in tempering in oil; *ib.* 3018-3043. The tempering of steel in oil adds much to its hardness and toughness. The working of the process is left to the practical knowledge of the men employed; the evils of tempering in large masses are greater than the advantages to be gained. Sometimes barrels get crooked in tempering, thereby denoting want of homogeneity in the metal. So large a mass of steel as a 600-pr. shot would, if tempered, be liable to "fly" when fired against armour plates; *Noble* 3374-3401. The steel supplied for the manufacture of the Whitworth guns is subjected to a hardening and tempering process by being heated to a certain temperature and immersed in oil, the proper heat for each piece of steel being found by experiment; and the witness feels perfect confidence in this temper being properly applied to a large mass of this metal as easily as to a small one; *Whitworth* 3731. 3766-3773. 4101-4104. The Whitworth barrels are first turned and bored before tempering; *ib.* 3736. The temper given to the steel projectiles is different to that of the gun barrel; they are made harder and the metal of which they are composed contains a little more carbon; *ib.* 4098-4100. Percussive action is not more injurious to steel or homogeneous metal than to wrought iron, if it is properly tempered, the whole value of steel depending upon the treatment of it; *ib.* 4105-4108.

#### THREE-HUNDRED-POUNDER ARMSTRONG GUN:

Witness submits to the Committee the 300-pr., weighing 12 tons, rifled on the shunt principle, and proposes to provide it with projectiles for use against

ordinary objects, and also special projectiles of steel available for use against armour plates; gives the calibre as 10½ inches, and the twist of rifling one turn in 65 calibres. The steel shell to be about two calibres in length, containing a bursting charge of 12 to 14 lbs. of powder; *Armstrong* 164-168. Witness considers that no gun under 300-pr. or 600-pr. can do any real harm to armour-plated ships; *Alderson* 662. Statement that prior to the introduction of Mr. Whitworth's special projectile the "Warrior" target had only been penetrated by a shot from the 300-pr. smooth-bore gun; *Harrison, A.* 1414. Witness mentions that the 150-pr. which burst at Shoeburyness was of the same size and calibre as the gun known as the 300-pr. rifle gun, the former being employed as a smooth-bore; *Taylor* 1561. Evidence states that in the larger Armstrong guns, 300-prs. and so on, have all shown a weakness from a particular cause, and mentions his objection to the method of plugging up the end of the inner tube, and recommends instead a solid inner tube supported from behind by a large screw; *Anderson* 2488. For dimensions, weight, &c. of 12 ton gun or 300-pr., see Letter, tabular return; *App.* 156. 159. The difficulty of obtaining the steel barrels for 300-pr. free from flaws; *Noble* 3241. 3246. Witness mentions the number of grooves in the 300-pr. shunt to be eight; *ib.* 3663. Statement of the cost of ingot of steel for the barrel of 300-pr. to amount to 300*l.*; *ib.* 3626.

#### THREE-POUNDER WHITWORTH:

Witness proposes the Whitworth 3-pr., and mentions its range at Southport, and other points connected with it; *Whitworth* 1. 8. 20. 25. For dimensions, weight, cost, &c. of Whitworth 3-pr. gun; *App.* 161.

#### TIME FUZE. See FUZE.

#### TIN PROCESS. See COATING PROJECTILES.

#### TOUGHENING IN OIL. See TEMPERING.

#### TRAINING:

Witness states that he was not satisfied with the facility for training the 110-pr. Armstrong gun on board ship, from the shortness of the carriage owing to the nature of the gun; *Powell* 2228.

#### TRAJECTORY:

Witness mentions the importance of the low trajectory of the 1-pr. Whitworth gun; *Whitworth* 4. Evidence cannot conceive anything more to be desired in the Armstrong gun as far as range is concerned, except lowering the trajectory a little; *Liddell* 945. 946. Opinion that lower trajectories will be obtained by using gun cotton than with gunpowder; *Whitworth* 3942-3947.

#### TRAVERSING:

Witness has applied the traversing bar to his guns, but not to those made lately, having learned that military men prefer the simple movement of the trail; *Whitworth* 56. Evidence mentions the decided advantage of the traversing arrangement with Armstrong guns; *Milman* 821, 822. Witness considers that the traversing screw would not be of any use on board ship from the sheering about, and other causes; *Liddell* 952. Witness mentions the importance of the traversing arrangement to the Armstrong guns, as it permitted him to lay his guns without shifting the carriage when acting in very soft ground in China; *Milward* 1358.

#### TRIALS. See EXPERIMENT.

#### TWELVE-POUNDER ARMSTRONG AND WHITWORTH GUNS:

##### 12-pr. Armstrong gun.

The 12-pr. Armstrong proposed to the Committee as a field gun; *Armstrong* 119. Witness mentions the severe proof some 12-prs. have stood, gives the number of fragments into which the 12-pr. shell breaks up into, and the prices at which the shell are manufactured; *ib.* 136. 152-155; *Noble* 3670-3675. Evidence favourable to the 12-pr. Armstrong gun; *Cow, S.* 285. 286. 294. 352; *Cow, J.* 415. 419; *Alderson* 580; *Liddell* 954, 955; *Milward* 1327; *Taylor* 1486, 1487; *Hewlett* 2110, 2111. Opinions that the 12-pr. Armstrong gun was useless for boat service; *Glyn* 1947. The practice of Armstrong 12-pr. in New Zealand was unsatisfactory; *Seymour* 1993. 1996. 2018. Opinion

that the 12-pr. Armstrong was unfitted to stand the rough usage of the service; *Glyn* 1947; *Seymour* 2000; *Gardener* 2609. 2645. 2672. 2685. Evidence mentions the difficulties he has found in working with the 12-pr. Armstrong; *Bower* 1623-1639. Witness states the details connected with the manufacture of the 12-pr. Armstrong gun at the Royal Gun Factories; *Anderson* 2351. 2359. 2364-2371. 2374. 2389-2393. 2397-2405. 2459. 2967. The competitive 12-prs. supplied to the Committee are alike in construction; *Noble* 3225. There is little difficulty in obtaining the steel barrels for the 12-prs. in good order and free from defects; *ib.* 3238. The cost of the steel barrels for the 12-prs. are proportionately much less than for the larger natures of Armstrong gun, in consequence of the ease in obtaining the steel ingots of that size free from flaws; *ib.* 3303-3305. Statement that all the 12-pr. steel barrels are tempered in oil; *ib.* 3375. Dimensions, weight, calibre, and cost of 12-pr. Armstrong gun and projectiles, &c.; *App.* 159, 160.

#### 12-pr. Whitworth gun.

Witness mentions the length of range attained by 12-pr. Whitworth, and gives other particulars connected with it; *Whitworth* 6. 7. 9. 13. 17. 39. 62. 3724-3727. Evidence of the extreme accuracy of the 12-pr. Whitworth gun; *Alderson* 623; *Milman* 736-747; *Bower* 1621; *Gardner* 2731. Witness states that the 12-pr. Whitworth equalled the 12-pr. Armstrong in facility of working; *Alderson* 624. Statement that the 12-pr. Whitworth guns at Hythe were worked very easily; *Isacke* 2804. Witness considers that of the two guns the 12-pr. Whitworth is easier worked than the 12-pr. Armstrong; *Best* 2949. Evidence of a 12-pr. brass Whitworth having become damaged in the bore, and would not permit of loading in consequence; *Cox*, S. 301. 306; *Cox*, J. 506; *Alderson* 619; *Taylor* 1498-1500. Evidence of the experiment carried out at Shoeburyness between 12-pr. breech-loading Armstrong and Whitworth guns for rapidity of fire; *Taylor* 1481-1485. Statement that there is no difference in the construction of the 12-pr. competitive guns from the others which have been hitherto made; *Whitworth* 3722-3724. The cost for the steel for the 12-pr. Whitworth is 60l. per ton, and the manufacture of the gun increases the price up to 120l.; *ib.* 3782. 3804. Dimensions, weight, calibre, cost, &c. of 12-pr. Whitworth gun, with projectiles; *see App.* 161.

#### TWENTY-POUNDER ARMSTRONG GUN:

Evidence proposes a short 20-pr. of 13 cwt. for field service as a howitzer or shell gun; *Armstrong* 194. Witness recommends two short 20-pr. Armstrongs for each field battery, and considers them very good shot guns up to 3,000 yards range; *Alderson* 605-609. Recommendation of the introduction of the short 20-pr. as a shell gun for field artillery; *Milman* 842, 843; *Milward* 1325-1327; *Desborough* 1466; *Hewlett* 2121. Witness mentions his approval of the projectiles for the 20-pr. Armstrong gun; *Milman* 855. 857. Statement that the accuracy of the 20-pr. Armstrong is not equal to the other natures of Armstrong guns; *Bechervaise* 1202. Witness mentions that the 20-pr. had been reduced in weight to adapt it to boats; its recoil is violent, but still prefers it to the 24-pr. smooth-bore howitzer; *Hewlett* 2116, 2117. Evidence of the details of manufacture, and the number of 20-prs. manufactured and proved; *Anderson* 2394, 2395. 2531. 2967; *App.* 164, 165. Dimensions, weight, cost, &c. of 20-pr. Armstrong gun, with detail of stores accompanying it; *App.* 159, 160. 162. 164.

#### U.

UNDERCUTTING. *See COATING PROJECTILES.*

#### V.

#### VELOCITY:

Witness states that in consequence of the larger bore of the Armstrong guns, comparatively to the Whitworth system, that the former can start the projectile at a higher initial velocity, although, from atmospheric resistance, it is not retained so long; *Armstrong* 168-173. Evidence mentions the initial velocity of the 12-pr. Armstrong gun at 1,242 feet per second; the 70-pr. Whitworth, with shell, 1,184, and 1,062 with shot. The velocity of rotation is very

different between the Armstrong and Whitworth projectiles; *Milman* 745. 749. 754. Statement that the gun which can stand the greatest charge, and thus give high velocity, will be the best for the penetration of iron plates, when the material of the projectile is best adapted for the work to be done; *Harrison*, A. 1424. Witness states that the initial velocities of the various guns under consideration will be found in the Report on Ordnance, of 25th July 1862, page 267; *Taylor* 1551. Opinion that the rifle gun which can stand the heaviest charge, and thus give the highest initial velocity, will effect the greatest injury to the iron plates; *Hay* 1832. Evidence of the increase of velocity and range gained by shortening the shot of the 110-pr. Armstrong to the weight of 68 lbs.; *ib.* 1840. Witness mentions that in the Lancaster guns used in the Crimea the muzzles had all the work to do when the shot was going out with enormous velocity; *Anderson* 2480. Tables of mean observed velocity, and the comparative gain or loss of velocity of the 12-pr. Armstrong and Whitworth guns; *App.* 368-371.

#### VENTS:

Evidence prefers the vents for the Whitworth guns being placed in the continuation of the axis of the gun, as interfering least with the strength of the piece, and when it is placed in the ordinary manner on the top thinks it necessary to have an extra hoop on the Whitworth guns; *Whitworth* 3750-3753. 3935-3937.

#### VENT-PIECES:

Evidence on the plan of construction for Armstrong guns, and mention of the vent-piece being tightened up by breech-screw; *Armstrong* 123. Opinion that for large guns the wedge principle was best, as avoiding the necessity of lifting the vent-piece; *ib.* 126. The vent-pieces made at the early stages of manufacture of the Armstrong gun were made of steel, and subject to variation in quality; they have since been made of Swedish iron, which has been successful; but a perfect vent-piece should be made of mild steel, tempered in oil; *ib.* 217. Evidence that the vent-pieces of the Armstrong guns are liable to be blown out or injured on firing when made without the projecting strengthened back; *Armstrong* 211; *Cox*, S. 251. 255. 385; *Cox*, J. 436. 450. 464-466; *Alderson* 592; *Liddell* 986-996; *Bechervaise* 1224; *Milward* 1359-1361; *Taylor* 1555; *Seymour* 1995; *Hewlett* 2134-2136; *Powell* 2228. 2233-2239; *Anderson* 2514; *Gardner* 2640. 2645. 2662. Statements that the new pattern vent-pieces for Armstrong guns with projecting backs are not liable to be blown out, or injured from firing; *Armstrong* 159. 214; *Cox*, S. 247. 248. 252. 253; *Cox*, J. 436; *Alderson* 593; *Milman* 901; *Liddell* 995-1000; *Taylor* 1487; *Hewlett* 2138-2144. Witness states, in opposition to the above, that the projection at the back of the Armstrong vent-piece is not a security against their being blown out; *Gardner* 2646, 2647. 2659-2661. Evidence of the difficulties experienced in the working of the vent-pieces of the 110-pr. Armstrong, from their jamming, owing to the tin cups used to stop the escape of gas; *Cox*, S. 368; *Alderson* 656; *Milman* 828. 901-909; *Liddell* 1008, 1009. 1035; *Bechervaise* 1210-1212; *Powell* 2294, 2295. 2305; *Gardner* 2638, 2639. Statements that the vent-piece of the Armstrong gun is the weak point in the system; *Cox*, S. 399-401; *Alderson* 587; *Milman* 912, 913; *Bechervaise* 1274; *Harrison*, A. 1424; *Taylor* 1487. Evidence of the heating of vent-pieces in Armstrong guns from continued and rapid firing; *Cox*, S. 335-337; *Cox*, J. 454-457; *Gardner* 2645. Statement that since the addition of handles to the vent-pieces, that there has been no difficulty in removing them when hot; *Cox*, J. 458; *Liddell* 1175. Witness mentions that rapid firing in some cases causes the loosening of the copper ring on vent-piece, which is generally the forerunner of the breaking of the vent-piece; *Cox*, S. 338-342; *Liddell* 1173. Evidence of difficulty found in lifting the vent-pieces of the heavy Armstrong guns; *Cox*, S. 367; *Milman* 790-793; *Anderson* 3000. Opinions that there is no difficulty in lifting the vent-piece of the 110-pr. Armstrong gun; *Liddell* 1051-1054; *Rice* 1919; *Hewlett* 2082. Statement of witness that the proof of vent-pieces is expensive, and has caused the destruction of a large number of guns. That the different changes of pattern in vent-pieces has occasioned difficulty in supplying ships of war on distant stations, unless an accurate description of the gun, and the number of the vent-piece injured be given; *Gordon* 1775-1779. 1805-1809. Witness gives



opinion that the weight of the vent-piece in the 12-pr. Armstrong is objectionable, and if it is not weighty it will break, and if the breech-screw is not home a blow on the vent-piece is more liable to injure it than when it is screwed home; *Anderson* 2514, 2529. The material for the manufacture of vent-pieces is now had from Sheffield, also a particular brand of Swedish iron used in their construction, called "C and half moon." The vent-pieces tempered in oil have sustained a severe trial by firing, and it is found that they will not break when tested under the steam hammer; *Anderson* 2526-2528, 2534-2536, 3024.

### W.

#### WADS:

Witness states opinion that if the Whitworth gun were adopted it would be necessary to use a wad to keep the shot home; *Hewlett* 2061. Witness recommends the use of a stiff oakum wad with the Whitworth gun to prevent the rush of gas through the windage; *Whitworth* 4073.

#### WASHING:

Evidence of 100 rounds being fired from Whitworth guns without requiring washing out although no lubricating wad had been used; *Whitworth* 82.

#### WEAR AND TEAR:

Witness contends that the wear of the Whitworth gun in the bore is not caused by the friction of the projectile but is more due to the action of the gas, the powder chamber being the part of the bore that wears most; *Whitworth* 103-106, 4073. Evidence is of opinion that the rapidity of twist in the bore of the Whitworth gun has a tendency to wear it out; *Coar*, S. 300. Statement that although the Whitworth gun may wear the bore from the rapidity with which the projectile is turned round, yet it will stand an immense number of rounds. The wearing in a brass Whitworth will cause increased windage and not affect the accuracy to any considerable extent; *Boxer* 1658-1660. Opinion that the projectiles coated with soft metal possess advantages over the Whitworth projectiles, as the latter with hard metal surfaces are more liable to wear the bore of gun from friction; *Hay* 1836. Evidence mentions the wearing of certain brass Whitworth guns which had been under experiment at Shorncliffe; *Isacke* 2835-2837; *Best* 2891; *App.* 165.

#### WEDGE GUN. See BREECH-LOADERS.

#### WEIGHT:

Evidences give opinions as to the limit of weight which they think correct for broadside guns; *Hay* 1840, 1841; *Hewlett* 2083; *Powell* 2266. Weights of Armstrong and Whitworth guns; *App.* 159-161.

#### WELDED METAL. See FORGING.

#### WHITWORTH JOSEPH, ESQ. (Analysis of evidence.)

The Manchester Ordnance and Rifle Company are making 1, 3, 6, and 12-pr. field guns; would recommend a 9-pr. to be used as a field gun instead of a 12-pr. Mentions the performance of the 1-pr. as superior in range to the 12-pr. of the service, and contrasts their relative mobility; 1. Reckons the calibre by the diameter of the circle circumscribing the bore; considers that wherever the 1-pr. can be substituted for the small arm rifle it would be an immense advantage; 4. Have not yet made a 9-pr.; 11. The guns mentioned are muzzle-loaders, but has some 12 and 6-pr. breech-loaders; 13. The charge is one-sixth the weight of a shot of three diameters in length; shells are sometimes made four or more diameters long; 16. Considers a brass 12-pr. may be made of 10 cwt., but would not recommend it lighter; 17. Having stated to the Committee the guns made, leaves it to them to select; 21. Recommends the use of a separate gun for shell firing; 26. Has not got the plan for shell gun settled yet, but contemplates increasing the calibre without adding to the length of the projectile; 30. Claims to fire longer projectiles from his guns than were thought of before; has fired some 10 calibres long without difficulty by diminishing the charge, and giving plenty of rotary motion; 34. Would permit of a shell and shot being fired from the same gun. But would have a larger one for shrapnel; 46. The fuzes in the Whitworth projectiles are ignited by the flame of the charge passing over the shell; 50. Recommends muzzle-loading for field guns; 52. Con-

siders that the danger owing to refuse flannel being left behind in the bores of guns would be obviated by the use of solidified powder; 54. The shell takes the ordinary fuzes of the service; 75. The windage of the gun is given on the going in side, leaving the coming out side perfect; the metals have their full bearing throughout. The bore is peculiar, it has 24 surfaces; 78. Any amount of windage required can be given; 82. Would recommend the use of a lubricating wad; 83. Have had no cases of the shot sticking in the bores since the first guns made, which had not enough windage; 84. Considers that the possibility of jamming the projectiles in the bore to be no more than with any smooth-bore gun; 92. Thinks that the action of the gas will wear the bore of the gun more than the friction of the projectile; 103. The powder chamber the part of the bore that wears; 104. The details of the shrapnel shell has been left with Colonel Boxer; 115.

#### Further examination.

Relative to the expense of the Whitworth guns, witness is prepared to answer any questions; it is difficult to pronounce on the cost of a thing; 3721. There is no difference in the construction of the guns furnished for experiments of the Committee, and those previously made; 3722, 3723. The 12-pr. is made of homogeneous metal tempered, and is a solid gun, 3724-3726. The materials for the construction of this gun is supplied partly by Krupp and partly by Firth; each piece is tested and subject to the hardening and tempering process; 3728-3731. Messrs. Firth agreed to pay a royalty of 2 per cent. for all gun material which they supply to others, for using our patent right, with the exception of the supply sent to the American States. It was not considered a royalty, but was agreed to in consequence of the assistance rendered to them; 3732-3747. The different apparent construction of the gun furnished for the experiments from those previously manufactured has been caused by placing the vent in a position not originally intended for it; 3748-3753. The trunnion-piece is put on cold by the screw. The ring on the breech-piece is put on by hydraulic pressure, and not by heat; 3754-3758. The barrels are sometimes cast hollow, and sometimes solid, they are hammered at the steel factory and afterwards tempered in oil, hardened and tested in the Whitworth works; 3760-3777. The price of the metal is from 60l. to 90l. per ton, according to size; the comparative value of the metal when worked up depends on the size of the gun. Before tempering, the barrel is first turned and rough-bored, and a piece taken off from the end to test the metal; 3779-3787. The proportion of ingots rejected is small; the makers would take them back, the loss of the workmanship being paid by the Whitworth firm. After the tempering process the barrel is again turned on the outside, and then gets the finish boring and the rifling; great exactness in tempering is required for the sake of the cutting tools, 3718-3798. The additional value to be placed upon the material after the tempering process varies with the size of the gun, that for the 12-pr. costing 60l. per ton, and as the gun weighs half a ton, and is sold for 120l., it would give the producing cost as four times the original value of material, which includes profit. It is difficult to state the cost of each process in the manufacture of the Whitworth gun; 3799-3809. The cost of the projectiles is of more importance than that of the gun, from the lasting nature of the latter, while the projectiles are continually being used. The present cost of 60l. per ton for gun material is no criterion of what it will come to, and it is probable it can be had for 30l. The Bessemer steel has in some instances been found very good by the Whitworth firm, and costs from 30l. to 40l. per ton. It is now being extensively used on railways; 3810-3819. Having found Messrs. Firth's metal exhibited much inequality, the Whitworth firm erected a steel works and now produce steel with more certainty. The Bessemer material for guns is preferable to iron, but it is not equal to the material melted in the crucible in the ordinary way. Only one Whitworth gun has been made of the Bessemer metal. Is prepared to give the Committee the results of the proof of the gun material for strength, and to show everything in confidence to the president and another member of the Committee. When the gun material shows no flaws, has perfect confidence in it; any defect in the ingot would be made known during the



process of manufacture; 3820-3832. The strength of the Whitworth gun material is two or three times as strong as wrought iron. The cost of its manufacture will always be more than wrought iron, but it is much cheaper, as if guns are to be made sufficiently strong, wrought iron would be unable to stand firing large charges of powder and long projectiles. Would not have anything to do with guns firing small charges. The best weight for a 7-inch gun would be 7 tons. With the slow burning powder used at Shoeburyness a charge of 10 lbs. with the 70-pr. Whitworth only gave 100 yards less range than before obtained by 12 lbs. of a quicker powder. The range at Southport with 12 lbs. of powder was 10,300 yards, firing on level ground; 3833-3852. Considers that if the charge of the Whitworth gun is 10 lbs. that the charge for the shunt gun should be 15 lbs. from the area of the bore being half as much again. The trunnions of the Whitworth gun are turned out of a solid block, and has the screw put upon it, the metal being the same as the other part of the gun. They have sometimes been made of wrought iron; 3853-3862. The Armstrong gun manufacture having been established some time, it has become as good as they are likely to get it. This is not the case with the Whitworth factory, as they look forward to a great diminution in price of the material. On comparing steel and iron rails, it has been found that the steel will last ten times as long, and their first cost is only 50 per cent. over the iron. A Danish gun supplied by the Whitworth Company burst. There has not been any account of other guns having failed, the success of those supplied to the Confederates has been heard of. There has been no failures with the guns supplied to the Egyptian Government. The bursting of the Danish gun was caused by too much air-space between the charge and the projectile; it burst into several pieces. At the time it was made there was no exact way of testing the metal; 3865-3892. In all cases of manufacture of 7-inch guns the bore is not completed until the hoops are put on, by hydraulic pressure, on a tapering portion of the gun, the relative proportion of the guns ruling the amount of taper given; for instance, with a taper of one inch in a hundred, the tube is forced up about  $\frac{1}{100}$ ths of an inch beyond the fit; by this means a more certain knowledge of the strain put on the material is known than by shrinking on by heat. Whatever the size of the gun the hoops are of the same metal; 3893-3904. The force exerted by the hydraulic pressure has been found sufficient to force on the hoops and prevent the barrel turning in the hoops. In the 70-pr. Whitworth the hoops placed over the barrel have been made in three layers, connected by a screw and pushed on at the same time. The experience gained by experiments still causes a preference for the position of the vent being in the axis of the piece; by so doing there is no inequality caused in the strength of the breech. But for the ignition of the cartridge it is better to fire it in the centre than at the end; 3907-3922. In the guns sent to foreign countries the breech piece has been screwed in the same way as the 70-pr. delivered to the Committee. No complaints have been received of the screw shifting; in some experiments at Shoeburyness it has done so, but that was considered satisfactory, as showing the ease with which it could be removed if necessary; it could easily have been prevented by the insertion of a key. The guns supplied to foreign governments have had the vent on the top, but the vent at the end of the breech is preferable, 3927-3937. The steel for the outer rings is proved in the same manner as that for the barrel. A gun manufactured with steel barrel, and having wrought-iron hoops superimposed is not so expensive as a gun made like the Whitworth gun, but for the sake of the future, with reference to the ammunition likely to be used, it has become desirable to have the strongest gun possible. The results of experiment with gun cotton are remarkable, with regard to recoil and the lowness of the trajectory. For its use a gun of the strongest material would be required, while the weight may be diminished; 3938-3951. The method adopted by Krupp of making guns of steel solid is objectionable, as being likely to cause unsoundness. It would be desirable to make the barrels for large guns hollow, such as 15-inch or 10-inch. The manipulation of steel has arrived at so much certainty as to permit us to feel every confidence in the 9-inch Whitworth of 16 tons. On the built up principle, the soundness of the steel ingot would allow of a gun being made with a

3-feet bore. The weight of solid shot for 9-inch is 320 lbs.; 3952-3964. There is no limit to the size of gun that may be made, but considers the gun of the smallest bore capable of doing the work would be the best, and recommends the use of shells of five diameters in length to be used against ships. The pitch in the rifling of the 9-inch is in the same proportion as the smaller guns; 3965-3982. The cost of the Armstrong and Whitworth guns cannot be contrasted by the price of the material, as the metal for each is received in different stages of manufacture. The turning of steel is slower than wrought iron, requiring more to be spent in wages; as steel becomes more perfect the hoops can be made to require less turning. There would not be a very great difference in the expense of shrinking on coils and putting them on by hydraulic pressure; 3983-3992. The cost of the projectiles supplied to the Committee cannot be taken as a fair criterion of their future cost, and considers that the fairest method of contrasting them with the Armstrong is to take into consideration the time taken up in the manufacture; 3993-4007. Steel projectiles were used for the Whitworth small arm rifle in 1857, and with large projectiles against the "Alfred" in 1858. wrought iron for projectiles is practically useless for penetration; 4008-4013. The witness was informed that at Woolwich arsenal the projectiles for the shunt and Whitworth guns have been made; 4019, 4020. Recommends that the Whitworth projectiles should be tooled after casting, although they can be fired without; the tooling costs 5*l.* per dozen for 12-pr. shot. The iron used is common cast iron. The manner in which shells break up seems to be in relative proportion to the length of the shell; 4021-4038. Recommends the use of stronger powder to get greater penetration and range, and mentions the good results obtained from gun cotton and compressed powder together; 4039-4066. Has known no instance of the barrels turning round, and thus spiking the gun by moving the place of the vent. It was stated that the Whitworth gun would wear in its bore from the friction of the hard metal, and that the shot would jam; such, however, is not the case. Recommends the use of a stiff oakum wad, to prevent the rush of gas getting past the shot and wearing the gun. No lubrication would be required. Found the wear of the 70-pr.  $\frac{1}{100}$  of an inch, after firing 1,000 rounds. There is no means of determining how many rounds the guns will stand; 4067-4090. Considers it would be beneficial if experiments were made with one gun, to watch effect of continual firing with it, taking measurements every 500 rounds. One system of rifling is as good as another if properly made. It is a question of economy; there is no system as cheap as the polygonal system taken in connexion with the projectile; 4091-4097. The steel of the projectiles contains more carbon than that in the guns; they are made harder. The whole value of the steel in the guns depends upon the skill of the treatment it receives in the tempering process. The method of melting steel has an element of certainty, superior to the puddling of wrought iron. Has suggested that the naval establishments might be made available for the manufacture of guns. The ores used for making the steel are foreign, made with charcoal principally from Sweden and Russia; 4098-4114. The steel hitherto supplied by the Whitworth firm in guns and projectiles has not been made by themselves. The price for which there is a large contract for 70-pr. Whitworth is 500*l.*; 4119-4132.

#### WHITWORTH GUNS:

Evidence considers the Armstrong gun of iron more durable than the Whitworth of brass, and mentions the difficulty in loading the Whitworth gun; *Cox*, S. 299-302. Witness thinks the 70-pr. Armstrong better than 70-pr. Whitworth, but the range of the latter was a little over. Mentions the sticking of shot in the bore of the Whitworth at Shoeburyness. Considers the Whitworth gun best for penetration; does not consider the Whitworth shell good; *Cox*, J. 498-500. 506-513. 529-533. 558-563. Statement of a Whitworth gun being disabled by a shot injuring the bore. It was equal to the Armstrong in accuracy and range. The Whitworth has beaten the Armstrong in penetration. A shell bursting in the bore of a Whitworth gun would be liable to injure it. The range of the Whitworth is comparatively greater than the Armstrong, as it has a larger charge; *Alderson* 619-624. 663-666. 693. 706. Evidence states the ranges of the Whitworth brass field guns were greater



than the Armstrong, and that their accuracy was very great. There is not the same capacity for shell-firing in the Whitworth as in the Armstrong; *Milman* 734-742. 849-851. Mention of the achievement of the Whitworth guns in the penetration of iron plates; *Harrison, A.* 1404-1423. 1436. 1440-1444; *Whitworth* 4008-4016. Witness mentions the experiments between Armstrong and Whitworth 12-prs. to test rapidity of fire. Gives reason for preferring the Armstrong mode of rifling, and considers that a shell bursting in the bore of a Whitworth gun would prevent further loading with it. There is no doubt that the greatest penetration of iron plates has been attained by the Whitworth gun. Has no fault to find with the construction of the Whitworth gun. Objects to the form of the Whitworth projectile from the difference of length in the shot and shell, and considers the Whitworth shell arrangement not to be compared with the Armstrong. In the use of the fuzes there is an advantage in point of economy in the Whitworth gun; *Taylor* 1480-1485. 1498-1502. 1507-1509. 1531-1539. Evidence mentions his experiments made to determine the best form for the Whitworth shrapnel shell carried on with a brass 12-pr. Whitworth. The form of the shell was found satisfactory. The ordinary service time fuze was used, and no lubricators were required, which is a defect in any system to require a large amount of. If sufficient windage be given, it is not likely that shot will jam in the bore of the Whitworth gun. Considers that a gun rifled on the Whitworth system has as much chance of endurance as an Armstrong gun. The cost of the Whitworth projectiles is less than the Armstrong, the same metal being used in the construction. The cost of Whitworth 40-pr. is 3s. 4d., the solid shot about 2s. 2d. Some shells burst in the bore of the Whitworth gun and did no injury, but the bursting charge was small; a common shell with large bursting charge might injure the bore. It would not be safe to fire the ordinary case from a Whitworth gun; *Bower*, 1570-1582. 1644-1650. 1657-1660. 1666-1670. 1694-1697. 1732. Evidence mentions his opinion that the hard metal surface of the Whitworth projectiles will injure the bore of the gun. States that the accuracy of fit now given to Whitworth projectiles and the addition of the sabot has done away with the difficulties in loading. The principal merit for penetration of iron plates is due to Mr. Whitworth, although his shell did not convey through the iron of the target sufficient bursting charge to render it formidable; *Hay* 1836. 1841. 1849. 1850. 1856. Evidence states a preference for the Whitworth gun as a pivot, and mentions that the Americans approve of it; *Seymour* 2028, 2029. Witness states that he was directed five or six years ago to report on the Whitworth gun, and that he considered its accuracy and range very great, but doubted its safety. Since that time several of the guns burst. Objects to the hard metal surfaces working together in gun and projectile. Found difficulty in loading from the fouling deposit in the angles of the rifling, and hardening there; at first the shot went in easily, but in running out the gun found the shot started from its seat, necessitating the use of a wad. Mentions the splitting of the 80-pr. Whitworth gun of homogeneous metal. The penetration through water with flat-headed projectiles from a Whitworth brass howitzer was very good. The Whitworth gun has been more successful in the penetration of iron plates than any other gun; *Hewlett* 2051-2073. 2168-2170. 2188. Evidence considers that the hard metal surfaces of gun and projectile in Whitworth system, and the rapidity of twist, will not cause undue wearing away of the gun from friction; the comparative amount of torsion required to burst the Whitworth gun is placed by experiment

a 28 tons. The Whitworth method of breech-loading for guns is not likely to give satisfaction. The bursting of a shell in a Whitworth gun would injure the bore, if made of wrought iron, but if made of a steel harder than Krupp's it would not be so much damaged. By the method of putting on the hoops of the Whitworth gun on a conical surface by hydraulic pressure the full strength of the metal can be developed, if sufficient pressure is applied; *Anderson* 2475-2480. 2485. 3001. 3016. 3017. 3090, 3091. Witness considers the Whitworth gun wonderfully accurate, and to prevent shot sticking in the bore would recommend the shot to be cleaned before placing them in the bore; *Gardner* 2731, 2732. Evidence of the results of practice with 12-pr. brass Whitworth guns, which was considered good, although no accurate ideas of the practice could be formed, the targets being moored at sea. One of the guns fired 20 rounds in 13 minutes and 40 seconds. In firing the shrapnel shell prepared by Colonel Boxer, did not think that the practice obtained was as good as that with the Armstrong gun. There was no difficulty in loading the Whitworth gun. The guns were of two different weights, 11½ cwt., and the other 14½ cwt. After the firing the grooves of the Whitworth guns appeared to have worn a little. The accuracy of these guns was very good. The Whitworth gun is easier worked than the Armstrong; *Isacke* 2801-2803. 2806-2808. 2818-2821. 2825, 2826. 2835-2837. 2849-2851. 2854. 2859. Witness gives evidence relative to experiments with brass 12-pr. Whitworth guns. States that the shot before the Committee having a coating of brass upon it was fired from a Whitworth gun. Noticed wearing in the bore of the Whitworth after firing. Considers the practice from the Whitworth guns was much worse than that obtained from the Armstrong gun. Found no difficulty in loading the Whitworths. After dismantling the experimental guns, the light Whitworth of 11 cwt. was first into action, and although dirt had entered the muzzle, there was no difficulty in loading. The Whitworth gun is better than the Armstrong for ease of working, although not so good for practice; *Best* 2873-2881. 2891. 2899-2903. 2931-2939. 2949-2951. Statement of the Whitworth guns offered for competition, with general detailed description of them; *Whitworth* 1-115. 3720-4132. Cost of the guns manufactured on the Whitworth system, together with the methods pursued in their construction, and description of the material used, and the method of treating it; *ib.* 3720-4132. (See Analysis of evidence.) Tabular statement of dimensions, weights, rifling, and other particulars of the Whitworth guns offered for competition; *App.* 161. Examination return of four 12-pr. brass Whitworth guns after firing 200 rounds; *App.* 165.

#### WINDAGE:

Witness states that in the Whitworth gun the windage is left on the going-in side of the projectile. As much windage can be given as is considered requisite; if much is given the powder is wasted, but the shooting is not injured. In the early Whitworth guns there was not enough windage allowed. It is entirely a matter for experiment; it was found at the experiment at Shorncliffe that there was abundant windage; *Whitworth* 77. 82. 84. 91. Too little windage in the experimental Whitworth gun at Shoeburyness a cause of difficulty; *Taylor* 1481. Witness considers that the rush of gas through the windage of the Whitworth guns tends to wear the bore; *Whitworth* 4073.

WROUGHT IRON. See IRON.

#### Z.

ZINC PROCESS. See PROJECTILES.



LONDON:  
Printed by GEORGE E. EYRE and WILLIAM SPOTTISWOODE,  
Printers to the Queen's most Excellent Majesty.  
For Her Majesty's Stationery Office.





